MÉMOIRES DE L'INSTITUT D'ÉGYPTE. — TOME XVIII

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PRÉSENTÉS

A L'INSTITUT D'ÉGYPTE

ET PUBLIÉS SOUS LES AUSPICES

DE

SA MAJESTÉ FOUAD Ier, ROI D'ÉGYPTE

TOME DIX-HUITIÈME

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LACUSTRINE MOLLUSCA
FROM THE FAIYUM DEPRESSION

A STUDY IN VARIATION

BY ELINOR W. GARDNER. M. A., F. G. S.

LE CAIRE
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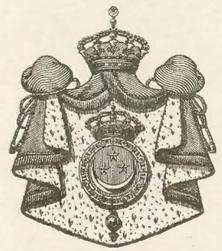

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CONTENTS.

PREFACE.

While working in 1925-1926 on the old lake beds of the Faiyum, under Miss G. Caton-Thompson, for the British School of Archaeology in Egypt, a molluscan assemblage was found which was utilised to distinguish the various deposits but was not examined in any detail.

On Miss Caton-Thompson's expedition in 1927 a new and much more interesting fauna was discovered, containing several new species and certain forms hitherto unrecorded from Egypt.

It is the object of the present paper to describe and discuss the whole molluscan fauna, with special attention to the problems of variation and their causes.

The malacological part would have been impossible without the unfailing help of Major M. Connolly, the well known authority on African mollusca. His unrivalled knowledge, not only of the African shells themselves, but also of the literature, his advice and criticism in the determination and description of species have been put most ungrudgingly at my disposal at all times.

I owe him a further debt of gratitude for the generous way in which he has allowed me to use his collection and excellent library, and for his kindness in reading part of the manuscript.

I am greatly indebted to Dr. Gertrude Elles, of Newnham College, for valuable criticisms and suggestions, and also to the Woodwardian Professor of Geology for the loan of a representative selection of

Corbiculae from the Cambridge river gravels, to Professor Stanley Gardiner for permission to examine the Bateson collection of Cardiua.

For permission to use both the collection and libraries under their charge I have to thank the authorities of the Malacological and Geological Departments of the British Museum, and also those of the Zoological and Geological Departments of the University Museum in Berlin. The latter were most generous and helpful, especially in the matter of photographing Schweinfurth's specimens and for permission to figure them.

I have further received invaluable assistance from Mr. A. W. Stelfox of the National Museum of Ireland, who has taken much trouble over the difficult genus Pisidium. The malacological report on it is entirely his work.

Mr. J. R. le B. Tomlin, Mr. Cox of the British Museum, Dr. Hume and Mr. Little of the Egyptian Geological Survey, Dr. Mermod and Dr. Favre of Geneva, M. Pallary and Dr. Wenz have all helped me in many ways. I wish to thank them, and also my late colleagues at Bedford College for time and trouble willingly expended. Particularly I would thank Mr. S. Morris, the Geological Laboratory Assistant, without whom the photography of the shells could hardly have been undertaken.

Finally to Miss Caton-Thompson my very best thanks are due for help and encouragement both in the field and at home, especially for providing, often at great personal inconvenience, opportunities to carry on the geological and palaeontological side of the work.

Funds for the purpose were provided in 1927 by the Percy Sladen Trustees, by Newnham College (from the Stuart Research Fund) the Geological Society (Gloyne Fund) and other generous donors.

The bibliography is not exhaustive, only the references most important for the paper being given. Further information on modern African forms, together with references to other works can be obtained from Pilsbry and Bequaert's book on the Mollusca of the Belgian Congo, which is invaluable in this connection.

I regret that the plates which were made up for reproduction natural size, have been reduced to four fifths throughout, thus making some of the smaller shells difficult to see.

Elinor W. Gardner.

Lady Margaret Hall, Oxford, May 1931.

INTRODUCTION.

Before the faunal descriptions and discussions can be undertaken, it will be necessary to give a brief account of the Faiyum Basin and of the changes which have taken place within it in Pleistocene and Recent times.

The Faiyum depression lies on the west of the Nile some 96 km. south of Cairo. It is an asymmetric basin with a steep northern edge, rising in steps to the high plateau of the Libyan Desert at 350 m. above sea level.

Below this northern escarpment lies the Birket Qarun, a brackish lake, 40 km. long by an average of 6 km. broad. Its greatest depth is a little over 5 m., while its surface at present (1930) lies at 45 m. below sea level.

This lake is the shrunken remnant of a larger sheet of water, which attained its maximum of 18 m. just prior to the advent of the Neolithic people.

This however was not the first lake to be formed. In Mid-Palaeolithic (Mousterian) times, the whole area was filled to the margin by water up to 35 m., with a storm beach to 40 m. — as Miss Caton-Thompson and the writer showed for the north side in 1926 and Messrs. Sandford and Arkell for the east and south in 1929. These gentlemen have also traced the 35 m. beach into the Nile Valley, with which the Faiyum is still connected by the Bahr Yusuf.

This stream, now artifically controlled, takes off from the Nile at Assiout and, flowing along the western border of the Nile Valley, enters the Faiyum through the Hawara Channel, whose surface of alluvium ranges from 28 m. at Lahun on the Nile Valley side to 24 m. at the Faiyum end some 10 km. to the north west.

The Nile Valley connection, then, established from the earliest times, has been the determining influence in the lake fauna, but certain European and southern elements enter in varying degrees and add variety and interest to the assemblages.

The Palaeolithic and Neolithic lakes were not directly continuous. After attaining its maximum, the Mousterian lake fell in stages with a particularly well marked pause at 22-25 m.

According to the writer the faunal and geological evidence points to the almost complete drying up of the waters, or at least their restriction to the deepest part of the depression, and the cutting off, temporarily, of the Nile connection.

Messrs. Sandford and Arkell, on the other hand, consider that fluviatile action was responsible for the formation of the lower levels in the Faiyum in post-Mousterian times, and that the lake after 22 m. gave place to a river which flowed through the Hawara Channel to join the Nile, which was at that time cutting its bed far below the modern level.

The light that the molluscan fauna throws on this problem will be dealt with when the lake assemblages are considered.

In examining the lake faunas it became obvious that there were considerable lateral and vertical variations, and an attempt will be made to correlate these variations with local conditions on the one

hand, and with the change from the Pleistocene to Recent times on the other. Finally a comparison will be instituted with the molluscan assemblages of neighbouring areas, in order to bring out the part played by migration in the composition of the Faiyum faunas.

Generalisations throughout the paper have been attempted where sufficient evidence warranted, in order to bring cohesion to otherwise isolated facts. It must be realised that these generalisations are for *the Faiyum only*, it remains for workers in other parts to test their wider application.

The conclusions as to migration in Pleistocene times must of necessity be tentative till further knowledge is obtained, but here again it has seemed better to put forward concrete proposals and suggestions, even if later they have to be modified.

One of the first to collect the subfossil fresh water faunas of the Faiyum was Georg Schweinfurth, who explored the area in 1879-1886. His shells were obtained chiefly from the island in the Birket Qarun, and from a prominent east and west gravel bank in the cultivation some 8 km. north east of Medinet-el-Faiyum, called the Edwa Bank. They were described by Martens in 1879 and 1886. The following species were determined by him.

FROM THE ISLAND IN THE BIRKET QARUN :

Planorbis cornu Ehr.
Valvata nilotica Jick.
Cleopatra bulimoides Oliv.
Melania tuberculata Müll.
Mutela nilotica Müll.
Nerietina nilotica Reeve.
Spatha ? marnoi.

Those from the Edwa Bank are dealt with later (p. 86).

Blanckenhorn made further investigations in the Faiyum. He collected from the northern area and also from the Edwa Bank. These faunas are discussed under the section on the Edwa Bank (p. 91).

In more recent years the shells of the modern lake have been described by E. A. Smith from specimens collected by Dr. W. A. Cunnington's zoological expedition in 1908.

GASTROPODA.

Family : SUCCINEIDÆ.

Genus : SUCCINEA Draparnaud 1801.

Succinea cleopatræ Pallary.

(Plate I, figs. 1-2.)

1874. *Succinea indica* "Pfeiffer" Jickeli : *Fauna N. O. Afrikas*, p. 167, pl. VI, fig. 11.
1909. *Succinea cleopatræ* Pallary : *Faune malac. d'Égypte*, p. 45, pl. III, figs. 29-30.

Distinguished from *Lymnæa* by the very long narrow last whorl, the relatively short slender spire and very oblique sutures.

The *Succineae* are amphibious animals, living sometimes on reeds in water and sometimes on damp ground and frequently on shrubs in the parched bushveldt far from any spot where water is to be found.

Only one example was collected in the Faiyum, and that in the upper beds of the Edwa Bank west of Edwa Station. Here there is every sign of disturbance at this horizon and the shell may well date from the historic period.

It does not resemble very closely the modern Egyptian species. The Faiyum shell seems to be more slender, with a longer spire, but it is considerably smaller than the specimen figured by Pallary and these differences may be due to differences in age.

Family : LYMNÆIDÆ.

Genus : LYMNÆA Lamarck 1799.

This is a particularly interesting genus for the geologist, since, of all the freshwater mollusca it seems to respond most readily to varying conditions. If, therefore, the origin of the different types of variation can be determined, a very valuable geological clue may be obtained.

Four species of *Lymnæa* are found in the different lake deposits. These are in order of abundance : — *L. lagotis* Schrank, *L. natalensis* Krauss, *L. cailliaudi* Bgt. and *L. mœris* Mrts. *L. truncatula* was thought to be represented by one fragmentary specimen collected in the northern gravels, but as it has not been found again either there or elsewhere, it will not be dealt with here.

The other species show an interesting distribution and some very remarkable modifications, which will be dealt with below. Of the four, *L. lagotis* is an eastern European form, not hitherto recorded from Africa; *L. natalensis* and *L. cailliaudi* are typically African, and *L. mœris* is apparently a local type, since it is not at present known outside of the Faiyum.

All the above — except *L. mœris* — belong to the group *Radix* of Montfort, characterised by a rather large shell, acuminate spire, never very long and often short, with an inflated and usually expanded outer lip. It belongs typically to the Palæarctic region.

Lymnæa lagotis Schrank.

(Plate I, figs. 45-105.)

1779. *Buccinum* Schröter : *Die Gesch. der Flussconch.*, p. 318, pl. 7, fig. 12.
1803. *Buccinum lagotis* Schrank : *Fauna Boica*, III, p. 290.
1833. *Limnæus acutus* Jeffreys : *Trans. Linn. Soc.*, XVI, p. 373.
1835. *Limnæus vulgaris* Pfr : Rossmässler, *Icon.*, Heft I, p. 97, pl. II, fig. 53.
1870. *Limnæus vulgaris* Rossmässler : Kobelt., *Mal. Blätt.*, XVII, pp. 149, 159-162, pl. III, figs. 9-10.
1870-75. *Limnæa lagotis* Schrank : Sandberger, *Land und Süsswasser Conchylien*, p. 949.
1884. *Gulnaria auricularia* var. *lagotis* Clessin : *Deutsch. Exc. Moll. Fauna*, I, p. 369.
1921. *Limnæa* (*Radix*) *lagotis* Schrank : Germain, *Moll. Syrie*, vol. I, pp. 385-396. 1922 vol. II, pl. XVII, figs. 2-5, 19-20, pl. XVIII, figs. 6-11, pl. XXI, figs. 12-13.
1925. *Limnæa lagotis* Schrank : Annandale and Rao, *Records Ind. Mus.*, vol. XXVII, part III, pp. 151-157, figs. 1, 1-10, p. 152.
1925. *Radix lagotis* (Schrank) : Geyer, *Arch. für Moll. Kunde*, LVII, pp. 58-63, pl. 2, figs. 1-6.
1927. *Limnæa lagotis* Schrank : Favre, *Les Mollusques du Bassin de Genève*, pp. 244, 246, 248.

Description. This species was originally described by Schrank from the Danube and is figured by Schröter. It is there described as «die bauchige Buccinum mit kurzem, spitzigen Zopfe». These are the two features most characteristic of the species. Of the four to five whorls, the body whorl is large, oval and swollen and much larger than the penultimate. The spire is rather short and very pointed — 1/3 to 1/2 of the aperture, and 4/5 of total length. The sutures are deep, the one between the spire and the body whorl often markedly so, and moderately inclined. The whorls are convex and may show a tendency to scalarity. The aperture is oval, the outer lip expanded, the inner narrowly reflexed. The columella is moderately twisted, the fold continuing down the lip and disappearing gradually near the basal margin. The inclination of this side of the mouth is generally outwards and not vertical. Size — most characteristic shells from 15-20 mm. high, 9-13 mm. broad.

Relation to other forms.

An immense amount of confusion has arisen in relation to this shell, in common with most Lymneas, as the number of pseudonyms shows. This is no doubt due to its great variability. Schröter considered it distinguished from the 'ear snails', *L. auricularia*, by the long drawn out mouth, greater number of whorls and character of the spire. He also thought that the animals differed from each other.

Messrs. Annandale and Rao would also separate the two species on the difference in the structure of the spire and columella fold.

Clessin regards *lagotis* as a variety of *auricularia;* Geyer also considers that it is related to *L. auricularia* by the modification of a small number of a *L. auricularia* colony through varying grades into *lagotis*. He thinks that this is due, not so much to internal forces of evolution as to external influences. In the south German types he also found *lagotis*-like forms derived from *L. ovata*. From this he draws the conclusion that since the lagotis character is developed from two different 'Formen Kreisen' it is to be attributed mainly to ecological conditions.

The great variability which is found in the Faiyum Pleistocene shells is also very characteristic of the modern types. Annandale and Rao describe six

different forms from India. Germain's figures of the Palestine species show at least three different types. Geyer mentions 16 varieties; he is also of the opinion that the peculiarities of build in *lagotis* arise not only from unfavourable (ungenügenden) but also from unhealthy (ungesunden) external conditions.

Lagotis, then, would seem to be specially suitable for reflecting changing conditions in the lakes, and an attempt to interpret the variations in relation to the geological evidence will be undertaken in the next section.

Normal Habitat.

Muddy and marshy waters, generally in lakes but also in canals, dead arms of rivers — e. g. Danube. It is therefore characteristic of stagnant and slowly moving water.

Geological Distribution.

The records of *L. lagotis* are given, but it is not certain that all forms so listed are necessarily similar to the type now known by the name. *L. auricularia* var. *acuta,* a synonym for *lagotis,* is recorded from the Tertiary — the Norwich Crag of Norfolk. This Pliocene form was represented by one immature specimen, but that figured by Searles Wood (1879, p. 36, pl. IV. fig. 3 *a*) does not closely resemble the Faiyum shells. Wenz (1923, pt. 21, p. 1237) lists it as occurring from the Astian to the present day. The most interesting geological record is that given by Sandberger of its occurrence in the lowest terrace — 20 ft. above the Neckar-near Heidelberg. Here it is found in loess-like clay banks with sand and gravel in association with *Elephas primigenius* and modern freshwater and terrestrial shells.

Geyer (*op. cit.*, p. 71) has found it in Quaternary deposits of Würtemberg, where certain types are very close to the Faiyum forms. Many of the shells are, however, markedly larger than the Egyptian species.

Favre records *lagotis* from the post-Pleistocene deposits of the Geneva basin, but it is not common either then or at the present day.

Present Distribution.

Typically an eastern European form but also found in the Near East and India — less abundantly in North West Europe.

Faiyum Forms.

The forms of *lagotis* now to be described were collected mainly from the low-lying isolated gravel bank at Tamiya, and from a shell bank at 22 m. on the west side of the Faiyum (see map). Astonishing variety is shown, particularly in the shells from the Tamiya Bank (figs. 64-105) which occur in a thin layer of marly silt. The geological aspect of the variation will be dealt with in the next section.

The shells nearest the type as figured by Schröter, are found in both places, but not in very large numbers, they are, moreover, rather small (figs. 47, 80, 81).

Variations.

The variations can be grouped about a central form, which is not, however, the type *lagotis.* From this, lines of variation or 'trends' — to use the valuable term introduced by Dr. Lang of the British Museum — seem to branch off, some being more dominant than others.

(*a*) *The central form* as shown in figs. 92-93 is a large, well grown shell 22.3 mm. high, by 18.5 mm. broad. The spire is shorter than the type, the sutures are less inclined, while the body whorl is larger and fairly inflated, but not excessively so. The aperture is oval, 17.7 mm. long by 13.3 broad. Ratio of spire to body whorl 3.8. These shells are found only in the Tamiya Bank and are always the largest among the numbers of *lagotis* accompanying them. The largest forms are not very numerous, but smaller ones of the same build are common.

The shell itself, both of this variety and all other Tamiya types is thin and translucent; a few only being opaque white.

(*b*) *Elongation of Spire* (figs. 45-47, 55, 56, 68-70, 77-81, 97). — This trend is the commonest one in *lagotis* from both areas and gives rise to a more elongated shell than either the type or the central form. This elongation is, however, produced solely by the lengthening of the spire, the body whorl remaining proportionately the same in shape as the central form. With the elongation of the spire the sutures tend to become more and more

oblique till at its maximum this trend gives rise to a true scalariform development (figs. 68, 77). All stages beginning with the 'sagging down' of the body whorl at the mouth, to the almost complete unwinding of the spire can be traced. The early stages of unwinding are fairly common but the extreme form is rare.

Scalariform types occur more commonly in the Tamiya Bank than elsewhere.

(*c*) *Shortening of the Spire* (figs. 50-52, 60-63, 101). — The next commonest variant is in exactly the opposite direction, i.e., in the shortening of the spire till it is only one ninth of the total length.

The extreme form of this trend appears, therefore, very globular in shape, the short spire giving the effect of greater inflation (figs. 51, 52, 101). In some forms this inflation of the body whorl actually does occur, but it is not an invariable accompaniment of spire shortening and may take place independently of it.

The extreme shortening of the spire occurs in both areas, but it is not very common, though a moderate amount of reduction is fairly frequent.

The end terms of the above two trends are so different (see figs. 52, 68) that if found separately they might warrant different specific names. As, however, a complete series of transitional forms can be found between them, they are here regarded as variants of one and the same species. A further reason for not giving different specific names is the very local occurrence of these varieties both in time and space.

It is of interest to note that the main variations in the Syrian *lagotis*, are, according to Germain (*op. cit.*, p. 389), in the same two directions, that is towards elongation on the one hand (var. *confinis*) and shortening (var. *hedachariyensis*) of the spire on the other. Both these are lake forms but from different localities.

The other variants are less common than the above, and either do not occur at all outside of the Tamiya Bank, or are only very sparingly represented.

(*d*) *Expansion and flattening of outer lip to produce a flange.*

Of these minor trends, the flattening and expansion of the outer lip to form a flange is the most striking (figs. 72-74, 84-87, 96, 102). All stages in its production can be observed, and it is found in both the long and short spired forms, though its maximum is attained in the short varieties.

The shells showing this modification are rather small and not very numerous.

A modification of this trend is seen in the actual reflexion of the lip but this is still rarer than the simple expansion (figs. 75-76).

Neither of the above types have, so far, been found outside of the Tamiya Bank.

(*e*) *Elongation of the Aperture.* — This trend, though not very common, is of some importance since other species of *Lymnæa* in the Faiyum show the same tendency. It may or may not accompany the elongation of the spire, and when it does a long shell, more tapering than either the type or the central form results (figs. 45, 88-90).

The angle at which the posterior end of the mouth leaves the body whorl is, in this trend, frequently a very oblique one, sloping straight down towards the base without first projecting out at right angles, as is the usual condition. This variant is not very abundant, but occurs in other localities besides the Tamiya Bank.

(*f*) *Lifting of the body whorl.* — This trend is a minor one, but quite characteristic. When the shell is viewed from the back it gives a high shouldered, 'hunched up' effect to the junction of the spire and body whorl (fig. 104). It is due to the partial enfolding of the spire by the last whorl as distinct from the sinking of the spire, which gives rise to deep sutures. The mouth in this form again tends to be elongated, but is quite different in shape from that in the above trend. The sides tend towards parallelism, while the outer lip bends upward instead of downward immediately below the suture.

Since in one and the same species there is every variety of angle at which the outer lip leaves the body whorl, it is obvious that this feature cannot be used for diagnostic purposes.

(*g*) *Thickening of shell.* — The tendency to thicken the shell is best developed in the specimens from the western 22 m. Bank (figs. 45-52). These

are much more opaque than those of the Tamiya Bank, heavier and, in some cases, of almost stone-like consistency. The thickening takes place throughout the shell, though the mouth may show a tendency to develop extra layers.

This general thickening of the shell is not found in the Tamiya Bank forms, though these occasionally show the apertural thickening and deposition of extra material along the inner margin (figs. 66, 96).

For *lagotis* there now remains to be noted a few abnormalities that have been found only among the shells from the Tamiya Bank.

Of these the occurrence of ridges and swellings on the body whorl is most frequent (fig. 65). This is due to some factor interfering with the continuous growth of the shell, or possibly some mechanical injury to the mantle which secretes the shell.

One specimen shows great abnormality about the mouth, which is thickened. The outer margin has a marked inward bend giving a very restricted opening, especially at the base (fig. 67).

Occurrence in Faiyum.

Lagotis is typically a southern and western form. It is found in the western Bank, in the isolated gravel outcrop of Qasr Qabali, in the Edwa and Tamiya Banks, all in Pleistocene deposits.

A few small specimens have been found in the 30 m. gravels west of the Roman Gebel in the north. It is unknown in the Neolithic lake.

Lymnæa natalensis Krauss.

(Plate I, figs. 33-37.)

1848. *Limnæus natalensis* Krauss : *Die Südafr. Moll.*, p. 85, pl. V, fig. 15.
1874. *L. natalensis* Krs. : Jickeli, *Fauna N. Ost. Afrikas*, pp. 190-191.
1909. *L. natalensis* (*L. alexandrina* Bgt.) : Pallary, *op. cit.*, p. 47.
1919. *L.* (*Radix*) *natalensis* Krauss : Germain, *Bull. Mus. Paris*, p. 185.
1920. *L.* (*Radix*) *natalensis* Krauss : Germain, *Voy. Babault*, pp. 129-131. Text figs. 10-30.
1927. *Lymnæa* (*Radix*) *natalensis* (Krs.) : Pilsbry and Bequært, *Bull. Amer. Mus. Nat. Hist.*, p. 110, pl. XI, fig. 3.

This *Lymnæa* and its varieties is of almost universal occurrence throughout Africa. The only part in which it is not found is the north west region.

In form the shell is much more ovate than *L. lagotis*, owing to the greater length of the body whorl, the more restricted mouth, and the greater breadth of the spire, which does not rise abruptly from the body whorl in the manner so characteristic of *L. lagotis*.

The spire is short with an acute apex, but the greater breadth at the base makes it appear relatively much shorter than the *lagotis* spire, which in fact it is not according to the dimensions given by Krauss and Jickeli. The spire is, according to them, 1/5 to 1/4 the length of the shell, which fits in well with the moderately elongated forms of *lagotis* of the central type. The sutures are almost horizontal and not so deep as those of *lagotis*. The early whorls are somewhat flat, but the last are convex. The body whorl never, however, becomes as inflated as in *lagotis*. The aperture is ovate, somewhat pointed and broad below. The columella is a gradual spiral, hardly folded, and with but a slight outward bend, less than in the typical *lagotis*.

Present Distribution. Whole of the Nile and its tributaries, nearly all the rest of Africa except the north west region.

Past Distribution. No record.

Faiyum Forms. The Faiyum *natalensis* agrees very well with the type in general proportions, but does not seem so large, the biggest being 16 mm. as against the 21 mm. of the type. It does not show any peculiarities of development such as are found in *lagotis*, the only variations being a tendency either to lengthen or shorten the body whorl, giving a more tapering or broader shell respectively.

Natalensis does not occur in such abundance as *lagotis*, and has so far never been found in great shell banks, such as that on the western side. Of the 19 occurrences in the northern Faiyum, 15 were from sand or gravel, the remaining 4 from clays. With regard to levels 5 are between 7 m. to 10 m., 5 between 10 and 12 m., 6 between 13 m. and 16 m., and 1 at 6.6 m., the lowest record for this form.

They are most frequently associated with the assemblage characteristic of

the Neolithic Lake (fig. 37), which attained a maximum of 18 m., but had a long 10 m. stage. It would appear likely, therefore, that *natalensis* lived in fairly shallow water near the shore, and this would probably account for its smaller size.

The biggest forms (figs. 33-36), occurring in pockets quite abundantly at the foot of the lake cliff near Qasr-es-Sagha, must have lived in the Palaeolithic lake, and from their situation were near the shore, but as the rise here is very steep, the water must have been of considerable depth. It is significant in this connection that these particular shells are more slender, as well as larger, than those occurring in shallower water. This variation in relation to depth is well known, and cited by Favre for the Lymnæas of the Geneva basin (*op. cit.*, p. 245). It is of interest to find that *natalensis* falls into line in this respect.

On the southern and western sides of the Basin the species *L. natalensis* occurs but rarely, if at all, and seems to be replaced by *lagotis*. The nearest approach to it is in the deposits of the Edwa Bank, where a form named by Martens *L. natalensis* Krauss *var.* occurs. This is a small shell, 14 mm. long with a broader spire than the average *lagotis*, which gives it a *natalensis*-like appearance (fig. 60-62). Every gradation can, however, be traced between this and the *lagotis* type which is the dominant one.

Relation of natalensis and lagotis. — It is possible that since *lagotis* or *lagotis*-like forms appear to develop from various species in the north, that *L. natalensis*, which is the dominant type in Africa, has given rise to a similar form, under the peculiar conditions of the lake.

In support of this hypothesis is the restriction of the *lagotis* in any numbers to the south and west sides of the Faiyum, which were the exposed shores, and the absence of this type, as far as is known, from other parts of Africa. On the other hand, it is common in Palestine, and with the greater rainfall of the pluvial period in the Pleistocene there seems no reason why it should not have extended its range to the south west. If this is so proof of it should be forthcoming from the Nile Valley Pleistocene deposits.

Lymnæa caillaudi Bourguignat.

(Plate I, figs. 38-44.)

1883. *L. cailliaudi* Bourguignat : *Ann. Sci. Nat. Zool.*, XV, p. 89, pl. X, figs. 100-101.
1909. *L. cailliaudi* Bgt. : Pallary, *op. cit.*, p. 46, pl. III, figs. 36-38.
1919. *L. africana* Rüpp (= *cailliaudi*, *alexandrina*, *laurenti*, *lavigeriana*, *acroxa*, *kynganica*, *zanzibarica* Bgt.) : Germain, *Bull. Mus.* Paris, pp. 181-185.
1920. *L.* (*Radix*) *africana* Rüpp : Germain, *Voy. Babault*, p. 141, pl. IV, figs. 6-11. Text figs. 31-59.
1927. *L.* (*Radix*) *cailliaudi* (Bgt.) (= *africana* Rüpp.) : Pilsbry and Bequaert, *op. cit.*, pp. 113-114.

In this shell the tendency to elongation of the body whorl is carried still further than in *natalensis*, and a more slender form results, with a relatively longer spire.

It is extremely probable that *cailliaudi* is but a modification of *natalensis*.

Present distribution. — Africa, except the north west, but extremely infrequent south of the tropic.

Past distribution. — Not known.

Faiyum forms.

Cailliaudi is mainly confined to the north, but it is not so common as *natalensis*. It is particularly characteristic of the white clays occurring in the small depressions of the first plateau above the Birket Qarun. These seem in many cases to be the first lake deposits resting directly on the Tertiary and running right up to the shore in some places.

They would, therefore, be on the whole deeper water deposits than those in which *natalensis* is found, and it is possible that *cailliaudi* is simply a modification of *natalensis* due to depth, carrying out to a further stage the variation noted in *natalensis* itself. This cannot, however, always be the case as, according to Major Connolly, both forms may occur together in the same small pool.

The depth hypothesis is to a certain extent borne out by the levels at which *cailliaudi* was found. Of the 12 occurrences, 4 are between 10 m. and 13 m., but *cailliaudi* is represented here by only a few specimens, 5 are between 7 m.

and 10 m., 2 between 4 m. and 10 m., and one below 4 m. These are, on the whole, lower than the *natalensis* levels.

A further piece of evidence for the greater depth of *cailliaudi* is found in the consideration of the association of the two Lymnæas with *Lanistes carinatus*. It seems fairly well established that the modern *carinatus* is an essentially shallow water shell, flourishing particularly in stagnant, marshy conditions. If the Pleistocene form had the same habits, it is significant that of the 11 instances in which *carinatus* was found in association with a *Lymnæa*, 10 were with *L. natalensis* and only one with *cailliaudi* and in the latter case there were only very few small specimens.

Lymnæa mœris MARTENS.

(Plate I, figs. 4-32.)

1886. *L. mœris* MARTENS : *Sitzber. d. Ges. Nat. Frn.*, Berlin, p. 126.

This *Lymnæa* was first collected by Schweinfurth from the Edwa Bank and described by Martens as a new species in 1886. The following is the description of the type given by him :

Elongate ovate, solid, striated, rimate, whorls 5 1/2, rapidly increasing, the upper not very convex, forming a mamillate apex. Suture but little oblique, the penultimate straight. The last whorl rounded, fairly ventricose, aperture a little longer than the spire, ovate oblong, moderately angulate above, columellar fold and callus distinct.

Long. 19 mm., Diam. maj. 10 mm., min. 7 mm.

Apert. alt. 11, lat. 6 1/2 mm.

He notes in regard to it that it is reminiscent of a small form of the European *stagnalis* described and figured by Kobelt as a dwarf or starvation form from the cold waters of the Jura and Rhone valleys (Zwerg oder Hungerform). He decides, however, that it is not related to *stagnalis* because the upper whorls are not so slender and do not run into each other in the manner characteristic of that species.

The specimens collected by the author were from Schweinfurth's type locality (figs. 5-15), where they were associated with a remarkable deposit consisting almost entirely of rounded calcareous grains the size of a pea, and

superficially resembling pisolites. Their mode of formation cannot be discussed here, but they certainly point to an excess of lime in the waters in which they were formed.

L. mœris was, however, also found in the Tamiya Bank, associated with the large *L. lagotis* (figs. 16-32). Here it is larger and thinner shelled than the Edwa Bank form and moreover shows the same tendency to variation as *lagotis*. Elongation of the spire and expansion of the aperture are noticeable features, but are not carried to the same extreme as in *lagotis*. *Mœris* is not so common in the Tamiya Bank as in the Edwa Bank.

Apart from these two localities, it has only been found in the low lying gravel bank at Qasr Qabali (see map), where it is apparently even rarer, one specimen only being found.

The type of *L. mœris* is not now in the Berlin Museum, but three specimens collected by Schweinfurth from the Edwa Bank and labelled by Blanckenhorn *L. palustris* were identical with the shells found by the writer in the same place and agreed exactly with Martens' original description of *L. mœris*. By the kindness of Dr. Dietrich and the Director of the Geological Museum, Berlin, the best of Schweinfurth's specimens (fig. 4) were photographed alongside of a Pleistocene *L. palustris* (fig. 3). With his permission this photograph is reproduced and it will be seen that, though superficially there is a general resemblance between them, they differ materially when examined in detail. The shape of the aperture is markedly unlike; in *L. mœris* it has a very characteristic basal expansion, while in *L. palustris* it tends to contract, giving an oval rather than an ovate shape. Further, the spire of *palustris* is more pointed, and the whorls decrease in diameter more rapidly than in *mœris*.

Martens, in describing Schweinfurth's collection, lists *L. palustris*, but says that it is represented by one small fragment only. The specimens mentioned above cannot, therefore, be the fragment to which he was alluding, and considering the variability to which all Lymnæa are subject, it would seem more likely that the so-called *palustris* was in reality but a fragment of *L. mœris*, especially as the mouth appears to have been broken.

It is, in any case, certain that Blanckenhorn's determination of *L. palustris* cannot stand for the three specimens mentioned above, and therefore that *L. palustris* should not appear in his list of shells from the Edwa Bank.

No form that could be named *palustris* was found by the writer here or elsewhere.

Relation of L. mœris to other forms.

The *Limnæa* which most closely resembles *L. mœris* is a fossil from the Lower Pliocene of Algiers. It was discovered by Philippe Thomas in limestone at Ain-el-Bey, and is described by Pallary, who named it *L. cirtana*, in his *Mollusques fossiles terrestres etc. de l'Algérie* (1901, p. 148). M. Pallary has seen the writer's shells, and while admitting the resemblance, considers that the greater flatness of the apical whorls in the Algerian form serves to distinguish it from the Egyptian shell. He suggests that the latter is more like the *Lymnæa* figured by Leiper (1916, p. 179) from marshy pools at the side of the Ismailia Canal at Bilbeis. Though the spire of this form resembles that of *L. mœris*, the aperture is quite different, being very much longer and showing a tendency to contract instead of to broaden at the anterior end.

To the writer, therefore, it still seems as if the Algerian Tertiary shell presents the closest affinities to *L. mœris*, but it is not suggested that this necessarily implies any specific affinity, since it may well be another instance of convergence due to similar external conditions.

Family : **PLANORBIDÆ.**

Sub-family : **Planorbinæ.**

This sub-family is well represented both numerically and specifically in the Faiyum lake beds.

Six species are found, of which all save one — *P. stanleyi* Smith — are still living in Egypt. As in the other groups, it is not always easy to define the limits of the species. This is particularly true of *P. alexandrinus* Ehrn, which shows considerable variation, and also of *P. planorbis* Linn.

Genus : **PLANORBIS** Geoffroy 1767.

Planorbis alexandrinus Ehrenberg.

(Plate II, figs. 1-11.)

1831. *Planorbis alexandrinus* Ehrenberg : *Symb. Phys. Mol.*, n° 1.

1874. *Segmentina* (*Planorbula*) *alexandrina* Ehrenberg : Jickeli, *N. O. Afrika*, p. 221, pl. VII, fig. 25, *a-f*.
1909. *Planorbis* (*Menetus*) *alexandrinus* Ehrenberg : Pallary, *op. cit.*, p. 55.
1924. *Planorbula* (*?*) *alexandrinensis* Ehrenberg : Pallary, *op. cit.*, p. 29.
1927. *Planorbula alexandrina* Pilsbry and Bequaert, *op. cit.*, p. 131.

Planorbis alexandrinus is distinguished by its rounded, rather thick whorls, increasing gradually in size. There is a fairly shallow umbilicus, and the last whorl, therefore, projects only slightly above the others. The aperture either carries on the line of the whorl, or projects slightly beyond it. The characteristic feature is the equality in length and parallelism of the upper and lower surfaces when viewed laterally (figs. 6-7). The typical young *P. alexandrinus* may or may not have 3-4 small teeth projecting into the last whorl a few millimetres inside the aperture, but if such are present the probabilities are that the specimen is *alexandrinus* (fig. 7).

It is a fairly common Lower Egyptian shell, but extends also along the whole course of the Nile and into Abyssinia.

The modern types are subject to variation in the degree of the closeness of volution and in the shape of the aperture, and in the Faiyum lake specimens these tendencies are still more marked.

To such an extent does this take place that it was at first thought some of the forms might be *Planorbis adowensis* Bgt., a Central and West African shell. On the collection of further material, however, shells with what may be termed the 'adowensis tendency', i. e. the deepening of the umbilicus consequent on closer coiling, the projection of the apertural margin beyond the line of the shell, and the more rapid increase in size, were all found in a specimen containing teeth (figs. 8-10). This shows that the peculiarities mentioned above are but variations of *P. alexandrinus* and not due to specific differences.

In the Faiyum the variant is much commoner than the typical form. The latter is shown in pl. II (figs. 1, 5, 6, 7, 11). Figs. 2-4, 8-10 are variants from various localities.

P. alexandrinus is found in both lakes, and, like all Planorbids and their modern representatives, is most at home in quiet or stagnant waters, as represented by the argillaceous beds. It does, however, occur in fine sands,

and is quite frequently found in the Neolithic lake assemblage from 10-18 m. At the lower levels it is not common, and no specimens were found in the deposits below sea-level in the north. This may be due to the chances of collecting, though it cannot in any case be common at these levels.

According to Pallary (*op. cit.*, 1924, p. 27) the species of *Planorbula* in fresh water are toothless, while those living in brackish water may develop teeth.

In the Faiyum lake deposits the majority are toothless. In two localities, however, relatively small shells with 3-4 teeth were found. In one case this occurred in a sand, probably of Neolithic age near Fidîmîn at 15 m. (pl. II, fig. 7 ($\times\frac{3}{5}$)) and in the other, 3 out of the 5 *P. alexandrinus* found in the 22 m. bank in the west had teeth. In neither case did the deposit, or the associated fauna suggest brackish water.

Planorbis stanleyi Smith.

(Plate II, figs. 12-18.)

1888. Jan. *Planorbis stanleyi* Smith : *Proc. Zool. Soc.*, p. 55.
1888. Nov. *Planorbis bridouxianus* Bourguignat : *Icon. Mal. Lac Tanganika*, pl. I, figs. 9-12.
1927. *P. bridouxianus* Bgt. : Pilsbry and Bequært, *op. cit.*, p. 119.
1927. *P. stanleyi* Smith (= *bridouxianus* Bgt.) : Connolly, *Journ. of Conch.*, XVIII, p. 173.
1929. *Planorbis bridouxi* Bgt. : Germain, *Bull. Mus. Paris*, p. 413.

This is perhaps the most interesting of the Faiyum Planorbids since it is no longer represented in the modern fauna of Egypt, being now confined to West and Central Africa and Abyssinia. It has only lately been recorded from the Nile System at Fashoda (Germ. 1929). Its synonymy with *P. bridouxianus* has been proved by Connolly.

It is distinguished from all the other Faiyum forms by its great thickness, the close coiling and rapid increase in size of the whorls.

Modern types show intermediates to *P. adowensis* Bgt., and it is possible that some of the Faiyum forms approach this species.

It is found in both lakes, but never in great quantities. Special interest, however, attaches to its presence in the white clays in the north, which are

the oldest Palaeolithic lake beds, since this shows that the Nile waters at that early date were tapping a wider faunal field than they do at present.

The presence of the species in the Neolithic lake argues for the continuance of a certain amount of water in the basin before the rise to the Neolithic level, unless it is a case of re-introduction like that of *P. planorbis*. There is not sufficient evidence available to settle this point.

In any case *P. stanleyi* appears to have died out before the lower levels of the Neolithic lake were reached. It has not been found below +2 m. It is not so wide spread as *P. alexandrinus*, and is commonest in the Palaeolithic white clays and in the fine sands of the higher levels of the Neolithic lake with typical Neolithic assemblage.

The size appears similar to modern forms : one of the largest measures 8 mm. maximum diameter, and 3.4 mm. high.

Planorbis planorbis (Linnæus).

(Plate II, figs. 25-34.)

1758. *Helix planorbis* Linn. : *Syst. Nat. ed.* 10, I, p. 769, no. 578.
1774. *Planorbis umbilicatus* Müll. : *Verm.*, II, p. 160.
1805. *Planorbis marginatus* Draparnaud : *Hist. Moll. Fr.*, pp. 45-46, pl. II, figs. 11, 12, 15.
1837. *Planorbis intermedius* Charp. : *Cat. Moll. Suisse*, p. 21, pl. II, figs. 11, 12.
1844. *Planorbis subangulatus* Philippi : *Enum. Moll. Sicil.*, II, p. 119, pl. XXI, fig. 6.
1864. *Planorbis subangulatus* Phil. : Bgt., *Malac. Algérie*, II, p. 153, pl. IX, figs. 27-30.
1886. *Planorbis subangulatus* Phil. : Küster, *Conch. Cab.*, p. 80, pl. XIII, figs. 26-28.
1909. *Planorbis* (*Tropidiscus*) *philippii* Monterosato : Pallary, *op. cit.*, p. 56, pl. IV, figs. 1-2.
1921. *Planorbis umbilicatus* Müller : Germain, *op. cit.*, I, pp. 415-23. 1922, II, pl. XVI, figs. 16-18, pl. XVII, figs. 6-7.

This common northern European shell exists not only all around the Mediterranean but in Asia also, with local variations and local names. Malacological authorities, however, seem now to regard them all as one race in Dr. Rensch's sense, and therefore the name of the type most generally found is here adopted. Further it serves to emphasise the North European element which apparently entered Egypt in the Pleistocene.

For the north and south Mediterranean region the name in general use seems to be *P. subangulatus*, for Syria *P. umbilicatus* and *P. marginatus*. Germain discusses the variations in the position and strength of the carina and distinguishes three types :

(1) Carina basal or sub-basal and well marked : *P. umbilicatus*, rare in Asia.
(2) Carina infra-medial, but not basal, more or less marked, nearly obsolete : *P. intermedius*, fairly common.
(3) Carina basal, but more or less obsolete : *P. marginatus*, greatest development.

Both the figures and descriptions of this last species agree with those given by Philippi for *subangulatus*. Küster considers that *subangulatus* differs from *marginatus* in being smaller and never having a thread-like carina. This distinction will, however, not hold, for in one and the same locality what is obviously the same species shows every degree of variation in the strength of the keel.

Pallary figures a *P. philippii* Mont. from Egypt, the origin of which it has been impossible to trace. It is obviously the same species as *P. subangulatus*, and occurs, as would be expected from the circum-Mediterranean distribution of this shell, in the lands bordering the sea coast of Lower Egypt. Though listed by Blanckenhorn from the Birket Qarun, it would seem to be a rare shell there and elsewhere in Egypt, since it was not found by Dr. Cunnington's expedition, nor by the author, nor is it mentioned by Dr. Leiper, Mrs. Longstaff or Dr. Innes.

The Faiyum shells agree with Germain's types (1) and (3); that is the carina is basal and may be well developed or practically absent, but every intermediate stage is found in one locality, therefore separate names will not be used for them. Those showing a distinct thread-like carina are in the majority. It seems to disappear first from the apertural end of the last whorl, and finally no trace of it is seen, only the angulation at the base of the whorls marking its position. The feature which distinguishes it from all other Faiyum Planorbids is its greater size and its plano-convex form which persists whether the carina is present or not.

It is generally a well developed shell, comparing favourably with modern

specimens — the largest measuring 12.8 mm. maximum diameter and 2.6 mm. thick — the majority being from 9-10 mm. in diameter and about 2.5 mm. thick. Both the modern and fossil South European and North African forms are distinguished from the northern European by the greater convexity of the whorls, which is well seen in a lateral view of the shell. In the typical *P. planorbis* the slope of the carina is a gentle one, in the southern types it is generally steep and abrupt.

Variations.

Besides the variation in the carina already referred to a fair proportion of shells show a slight tendency near the aperture to coil out of the plane previously followed, twisting downward to a greater or less extent, thus destroying the flatness of the base. This is generally not carried far and is seen at its maximum in pl. II figs. 28, 33.

In the above variation the whorls remain in contact, in two cases only was there a slight tendency to unwind from the apertural end, together with the downward bend.

Occurrences.

The most interesting point about this species is its distribution, both in space and time in the Faiyum lakes.

It is entirely confined to the Palaeolithic lake, and is there much more abundant in the south and west and south east than in the north, though one or two specimens were found on the plateau east of Mœris Bay.

In the Edwa Bank it is common in the calcareous series, but it was found in greatest abundance in a shell bank at 22 m. on the west of the Faiyum, together with *Lymnæa lagotis* and *Bithynia connollyi* (pl. II, figs. 25, 27-34). The lowest level at which it has so far been found is -1 or -2 m. in the Tamiya Bank, where it is only sparingly represented.

Its commonest associates are always *Lymnæa* and *Bithynia*, and like its modern counterpart it probably lived in still or stagnant water.

In undoubted Neolithic lake deposits it has *not been found at any level*, and if its occurrence in the present lake is substantiated it would seem to constitute a definite case of re-introduction at a much later date.

Only in the Edwa Bank and in the Nazla Drain were a few specimens found in beds whose age could not be definitely fixed.

Should it later be discovered in Neolithic deposits, its complete absence from the large number of faunas collected in the north shows that it had lost the dominance it held in Palaeolithic times.

Planorbis laurenti (Bgt.) Innes.

(Plate II, figs. 22-24 ($\times 1\frac{3}{5}$).)

1884. *Planorbis laurenti* Bgt., Innes : I, *Bull. Soc. Mal. Fr.*, pp. 332-333.
1909. *Planorbis* (*Menetus*) *laurenti* (Bgt.) Innes : Pallary, *op. cit.*, p. 56, pl. IV, figs. 8, 9.
1924. *Planorbis* (*Menetus*) *laurenti* (Bgt.) Innes : Pallary, *op. cit.*, p. 26.

This Planorbid is recorded at the present day only from Ismailia and the borders of Lake Timsah. It is distinguished from *P. mareoticus* by the greater altitude of the mouth, the closer coiling and greater rounding of the whorls which are fewer in number than in *mareoticus*, and the absence of a marked central carina.

In the Faiyum it is found sparingly in both lakes, generally in clays, but sometimes in fine sand.

It is of interest that the group to which this species belongs is, according to Pallary (*op. cit.*, 1924, p. 26) that of *P. maresi* Bgt., a Pleistocene Algerian form.

Planorbis mareoticus (Let.) Innes.

(Plate II, figs. 35-40.)

1884. *Planorbis mareoticus* Letourneux, Innes : *op. cit.*, p. 339.
1909. *Planorbis* (*Gyraulus*) *mareoticus* (Let.) Innes : Pallary, *op. cit.*, p. 57, pl. IV, figs. 5-6.
1916. *Planorbis* (*Gyraulus*) *mareoticus* (Let.) Innes : Leiper, *Journ. R. A. M. C.*, XXVII, p. 176, fig. 64.

This is a common Lower Egyptian shell, but has also been recorded from the Sudan (Longstaff, 1914, p. 242) though it does not seem to be abundant there.

It is distinguished by the fairly numerous whorls of small convexity, the broad and shallow umbilicus, and the presence of a central keel from which the sides of the whorls slope away gradually forming an acute angle along the central line.

In the Faiyum it is a very common shell in both lakes and at all levels. It is found abundantly in the argillaceous deposits, but occurs also in fine sands. It is rarely found in association with *P. planorbis*, being apparently entirely absent from the shell bank at 22 m. in the west, and at other places where *P. planorbis* is dominant. The two forms occur together in the lower deposits of the Tamiya Bank, where *P. mareoticus* is remarkable for its large size (pl. II, fig. 36). This specimen measures 10.2 mm. maximum diameter, and 2.1 in thickness. A *P. planorbis* of corresponding diameter is 2.4 mm. thick and this difference seems to be fairly constant. In other localities a diameter of 5.6 mm. would be considered a fair size.

Planorbis ehrenbergi Beck.

(Plate II, figs. 19-21 ($\times 1\frac{3}{5}$).)

1831. *Planorbis cornu* Ehrn. : *Symb. Phys. Moll.*, 2nd sp.
1837. *Planorbis ehrenbergi* (= *cornu* Ehrn.) Beck : *Index Moll.*, p. 119.
1855. *Planorbis cornu* Ehrn. : Roth., *Mal. Blätt.*, II, p. 50, pl. II, figs. 6-9.
1874. *Planorbis cornu* Ehrn. : Jick, *op. cit.*, p. 218.
1909. *Planorbis* (*Gyraulus*) *ehrenbergi* Beck : Pallary, *op. cit.*, p. 57.

This is the smallest of the Faiyum Planorbids, averaging 3 mm. in maximum diameter. It increases rapidly in size, has typically rounded whorls and a large mouth for the size of the whorl.

A slight carination may appear along the central line of the venter. Pallary considers this form intermediate to *P. mareoticus*.

It occurs commonly in both lakes and at various levels, but is particularly abundant in the Neolithic deposits below sea-level. Like the other Planorbids it is most frequently found in clays.

The living form seems to be confined to the Nile.

Genus : **SEGMENTINA** Fleming 1818.

Segmentina angusta Jickeli.

(Plate II, figs. 41-45 ($\times 1\frac{3}{5}$).)

1874. *Segmentina angusta* Jickeli : *op. cit.*, p. 220, pl. VII, fig. 24.
1909. *Planorbis* (*Segmentina*) *angusta* Jickeli : Pallary, *op. cit.*, p. 58.
1927. *Segmentina angusta* "Martens" Jickeli : Pilsbry and Bequært, *op. cit.*, pp. 129, 130, text fig. 11.

A typical African species, occurring in Central and East Africa but not in the south or north west. It was first described by Jickeli and is easily distinguished from all the other flatly coiled gastropods in the lake by the greater height of the shell, which resembles a very truncated cone with a nearly flat base. The last whorl embraces the others to a large extent and forms the bulk of the shell. The earlier whorls are only visible on the upper side. The umbilicus is small but very deep. The aperture is oblique and narrows at the periphery, the upper margin is arched and the lower almost straight. Its distinguishing feature is the presence of small partitions in the whorls. It is stated by Jickeli to be very rare at the present day in the Nile system and is recorded both by him and by Pallary mainly from the Upper Nile, where it was found on decaying reed stems; it is, however, listed by Innes from the edge of the Lake Mariout and around Mex near Alexandria.

In the Faiyum it is rare in the Palaeolithic Lake but has been found in the sandy deposits of the 22 m. stage. It does not seem to occur in the high level gravels.

In the Neolithic lake it appears to be confined to the north, and there may be found quite abundantly in the fine white sand at about 16 m., along with the broad-banded Theodoxids.

It has not been found in the lower levels in the north, but in the Tamiya Bank one specimen was found in the sandy gravel overlying the *Lymnæa* band. Here it is associated with a quite different fauna from that of the lower beds, and in all probability belongs to an early stage of the Neolithic lake.

Dimensions. — The fully grown forms measure 3.8 mm. maximum diameter, by 1.5 mm. in height, which agrees very closely with the smaller of the two sets of measurements given by Jickeli. None attain 4.87 mm., which is the greater of the two measurements.

Sub-family : **Bulininæ.**

Genus : **BULINUS** Müller (= **ISIDORA** Ehrn.).

Bulinus truncatus (Audouin).

(Plate II, figs. 47-51.)

1827. *Physa truncata* Audouin : *Descr. de l'Égypte*, XXII, p. 166. Atlas 1826, pl. II, fig. 27.
1874. *Isidora contorta* Mich. : Jickeli, *op. cit.*, pp. 203-205, pl. VII, fig. 14.
1909. *Bullinus* (*Isidora*) *contortus* Mich. : Pallary, *op. cit.*, p. 52, pl. III, fig. 39.
1916. *Bullinus contortus* Mich. : Leiper, *op. cit.*, p. 177, fig. 66.
1922. *Bullinus truncatus* (Aud.) (= *hemprichii*, *brochii* Ehrn.; *contorta* Mich.; *maresi*, *raymondiana*, *brondeli* Bgt.; *serecina*, *schackoi* Jick.; *lirata* Mouss.; *dybowskii*, *innesi* Pallary, *tiberiadensis* Preston) : Annandale, *Ind. Journ. Med. Research*, X, no. 2, pp. 484-487.
1927. *Bullinus contortus* (Michaud) : Pilsbry and Bequært, *op. cit.*, p. 135.

The identity of *Bulinus truncatus* with a large number of other species has been proved by Annandale, to whose work the reader is referred.

It is typically a small sinistral shell, with a short spire and very oblique sutures. The main variation, which has given rise to many specific names, is in the length of the spire.

It is a wide spread species, occurring in the countries bordering the Mediterranean, extending south into Abyssinia and possibly even to South Africa if *B. tropicus* is the same species.

The favourite habitat is muddy, often foul, water, sometimes in pools of drying marshes, where it crawls on the mud, or creeps up the stems of water plants. It is of economic importance since it is one of the carriers of Bilharzia.

In the Faiyum lake deposits it is present in great quantities in the clays, but is rare in the sands. It occurs in both lakes, but has not been found in the lower levels of the Neolithic one.

Like the modern race it shows variation in the length of the spire. The commonest form is one with a short spire like that in figs. 47, 48. Fig. 49 shows the spire-shortening carried to excess, while figs. 50, 51 represent the opposite tendency. It is noteworthy that the shell with the longest spire (fig. 51) is from the same bed in the Tamiya Bank as the greatly elongated Lymnæas.

Family : **ANCYLIDÆ.**

Genus : **FERRISSIA** Bryant Walker 1903.

Ferrissia isseli (Bourguignat).
(Plate II, fig. 46 (× $7\frac{1}{5}$).)

1866. *Ancylus isseli* Bourguignat : *Moll. nouv., lit.*, VII, p. 214, pl. 33, figs. 13-18.
1914. *Ferrissia isseli* Bgt. : Bryant Walker, *Nautilus*, XXVII, p. 126, pl. VII, figs. 4-8.

This small fresh water limpet is described and figured by Bryant Walker. It is found in Lower Egypt at Alexandria and at Ismailia, on papyrus leaves.

It is rare in the lake beds, one or two only having been found in the sandy deposit of the Neolithic lake associated with *Cleopatra bulimoides* cf. var. *richardi*.

Family : **AMPULLARIIDÆ.**

Two Pilas (formerly called *Ampullaria*) and a *Lanistes* represent this family in the Faiyum. All are typical Nile forms, but of the two former *P. wernei* is characteristic of the Upper Nile, while *P. ovata* is more abundant in Lower Egypt.

Genus : **PILA** Röding 1798 (= **AMPULLARIA** Lam.).

Pila ovata (Olivier).
(Plate II, figs. 59, 60.)

1804. *Ampullaria ovata* Olivier : *Voy. dans l'Emp. Othoman*, III (An. 12), p. 67. *Atlas*, pl. XXXI, fig. 1.
1874. *Ampullaria ovata* Olivier : Jickeli, *op. cit.*, pp. 230-32.
1909. *Ampullaria ovata* Olivier : Pallary, *op. cit.*, p. 60, pl. IV, fig. 12.

1916. *Ampullaria ovata* Olivier : Leiper, *op. cit.*, pp. 181-82, text fig. 76.
1925. *Ampullaria ovata* Olivier : Alderson, *Studies in Ampullaria*, p. 94, pl. XIX, fig. 9.
1927. *Pila ovata* (Olivier) : Pilsbry and Bequært, *op. cit.*, p. 181.

According to Leiper *P. ovata* was found only in the Bahr Yusuf leading into the Faiyum, but it is also known from Lake Mareotis near Alexandria, and various other parts of the Nile.

It is the largest Faiyum univalve, and while common in the north, is seldom found in the south of the depression. This is doubtless due to the different physical conditions in the two areas (see p. 75).

It is particularly well represented in the white clays, that is in the oldest lake deposits, but it is also found with *Lanistes* and *Viviparus* in loams on the margins of the basins, or in the rather argillaceous shore deposits of the various lakes.

This accords well with its modern habitat, for as a family the Ampullariidæ prefer the marshy low banks of rivers or swamps, ponds and lakes (Pilsbry and Bequært, p. 167).

The Faiyum shells are of good size, ranging from about 70 mm., but none are as large as the biggest given by Jickeli which is 92 mm. alt. by 79 mm. diam. maj.

Pila wernei (Philippi).
(Plate II, figs. 57, 58.)

1851. *Ampullaria wernei* Philippi : *Conch. Cab.*, p. 19, pl. V, fig. 4; pl. XVII, fig. 2.
1874. *A. wernei* Phil. : Jickeli, *op. cit.*, p. 232.
1914. *A. wernei* Phil. : Longstaff, *Linn. Soc. Journ.*, XXXII, p. 240.
1925. *A. wernei* Phil. : Alderson, *op. cit.*, pp. 89-91, pl. XVIII, figs. 2, 5, 6.
1927. *Pila wernei* (Phil.) : Pilsbry and Bequært, *op. cit.*, p. 183.

P. wernei is typically a White Nile shell which is distinguished from *P. ovata* by its shorter, more obtuse spire, with correspondingly lower, flatter whorls. The mouth according to Jickeli is higher and more strongly thickened.

It is rare in the Faiyum lake beds, and is only represented by young specimens. It has not so far been found in the Neolithic lake, and only in one locality with a typically Palaeolithic assemblage in a sandy clay.

It is of interest, however, in showing that at that time there was already northward migration from the upper waters of the Nile, and species were then introduced which did not survive in Lower Egypt in later times.

Genus : **LANISTES** Montfort 1810.

Lanistes carinatus (Olivier).

(Plate II, figs. 52-54.)

1786. *Helix bolteniana* Chemnitz : *Conch. Cab.*, IX, p. 89, pl. CIX, figs. 921-22.
1804. *Ampullaria carinata* Olivier : *op. cit.*, III, p. 68. *Atlas*, pl. XXXI, fig. 2.
1851. *Ampullaria bolteniana* Chemnitz : Philippi, *Conch. Cab.*, pp. 23, 26, pl. VI (1852), figs. 4, 5.
1901. *Ampullaria* (*Lanistes*) *bolteni* Chem. : Mayer-Eymar, *Viertl. sch. d. naturf. Gess. Zürich.*, pp. 23-27, pl. I, figs. 1-2.
1909. *Lanistes bolteni* Chemnitz : Pallary, *op. cit.*, p. 61, pl. IV, fig. 13.
1916. *L. carinatus* (Oliv.) (= *bolteniana* Chem., *bi-carinata*, *depressa*, *ægyptiaca* Ehrn.) : Sowerby, *Proc. Mal. Soc.*, XII, p. 65.

This is the only large sinistral shell in the lake assemblages. It is found always in shallow water deposits, particularly in those of a loamy nature.

It resembles the modern types collected on the surface of the Bats Ravine, and its main use in the lake history is as an indicator of shallow water, generally muddy conditions. This is its modern habitat in Central Africa, where it does not appear to be found in open deep water. In this relation it is noteworthy that *Lanistes* does not occur in the white clays, though plentiful enough in the lake marginal deposits.

It would appear to be one of the earliest freshwater inhabitants of the Faiyum region, since it is found in the Tertiary beds of the northern scarp (Mayer-Eymar 1901).

L. carinatus var. perfecta Pallary.

(Plate II, figs. 55-56.)

1909. *Lanistes bolteni* var. *perfecta* Pallary : *op. cit.*, p. 62.
1924. *Lanistes boltenianus* var. *perfecta* Pallary : *op. cit.*, p. 32.

This is a variant of *L. carinatus*, in which the carina is absent or very indistinct.

It is found sometimes alone and sometimes with the normal type in a few localities in the north of the Faiyum.

Both *Lanistes* are, like *Pila*, rare in the south, though *Lanistes*, unlike *Pila*, is found sparingly in the shell bank at 22 m. in the west of the Depression.

Family : **VIVIPARIDÆ.**

Genus : **VIVIPARUS** Montfort 1810.

Viviparus unicolor (Olivier).

(Plate II, figs. 61-63.)

1804. *Cyclostoma unicolor* Olivier : *op. cit.*, III, p. 68. *Atlas*, II, pl. XXXI, figs. 9 *a*, 9 *b*.
1852. *Paludina unicolor* (Oliv.) : Küster, *Conch. Cab.*, p. 21, pl. IV, figs. 12, 13.
1874. *Vivipara unicolor* (Oliv.) : Jickeli, *op. cit.*, pp. 235-239.
1909. *Vivipara unicolor* (Oliv.) : Pallary, *op. cit.*, p. 62.
1916. *Vivipara unicolor* (Oliv.) : Leiper, *op. cit.*, p. 181, fig. 74.
1920. *Vivipara unicolor* (Oliv.) (= *æthiops* Rve., *polita* Frfd., *nilotica* Bs., *alhiensis* Preston, *senegalensis* Frfd.) : Germain, *Voy. Babault*, pp. 195-234, text figs. 91-108.
1927. *Viviparus unicolor* (Oliv.) : Pilsbry and Bequert, *op. cit.*, p. 207, pl. XIX, fig. 1.
1928. *Viviparus unicolor* (Oliv.) : Prashad, *Mem. Ind. Mus.*, VIII, p. 180.

This common Nile shell does not call for any special mention. It is found in both lakes often in great abundance, and is generally associated with *Lanistes* and *Pila* in loams and other shallow water or marshy deposits.

The majority of the Faiyum shells are rather small, averaging about 20 mm. They generally show a distinct angle in the upper part of the whorls, but no biangulate forms are found.

The more recent *Viviparus* such as that in fig. 63 from a Ptolemaic deposit, seems on the whole to be larger, measuring about 26 mm., and comparing favourably with the measurements given by Jickeli. From a specimen in the Stuttgart Museum, this author records it as sub-fossil from the Libyan Desert but gives no more particulars.

Present Distribution. — The whole Nile System, including Victoria Nyanza and Abyssinia, West and Central and East Africa. A map of the distribution

of the genus, together with sub-fossil localities is given by Pilsbry and Bequært (*op. cit.*, p. 204). It is notable that the latter are in regions which are now desert.

Family : **TIARIDÆ.**

Genus : **CLEOPATRA** Troschel 1857.

Cleopatra bulimoides (Olivier).

(Plate III, figs. 23-27.)

1804. *Cyclostoma bulimoides* Olivier, *op. cit.*, p. 68, *Atlas*, pl. XXI, fig. 7.
1852. *Paludina bulimoides* (Oliv.) : Küster, *Conch. Cab.*, p. 32, pl. VII, fig. 11.
1874. *Cleopatra bulimoides* (Oliv.) : Jickeli, *op. cit.*, pp. 240-242, fig. 31.
1909. *Cleopatra bulimoides* (Oliv.) : Pallary, *op. cit.*, p. 63, pl. IV, fig. 16.
1914. *Cleopatra bulimoides* (Oliv.) : Longstaff, *op. cit.*, p. 238.
1916. *Cleopatra bulimoides* (Oliv.) : Leiper, *op. cit.*, p. 181, fig. 75.
1927. *Cleopatra bulimoides* (Oliv.) : Pilsbry and Bequært, *op. cit.*, p. 291.

This common Nile shell is subject to variation chiefly in the nature of the whorls which may or may not develop a carina. According to Jickeli the keel is confined to the upper whorls of the spire. Besides this type of variation, Mrs. Longstaff noted variations in the spiral angle and in the colour, the striped and keeled forms occurring higher up the Nile.

In the Faiyum similar variations are found. The most usual type is that shown in fig. 23, which is characterised by the gradual increase in size of the whorls and rather blunt spire. There is no carination. Frequently, however, angulation of the upper whorls is found. The extent to which this tendency develops varies; it may be confined to the first three whorls, or may extend to the whole spire, and even to the body whorl in addition. Both carinated and uncarinated forms occur together, and no cause can be made out for the presence or absence of this character. On the whole the carinated forms are in sands, and at the higher levels.

The second pronounced variation is in the character of the spire, which in some shells becomes very acute and consists of a large number of whorls. The latter increase more rapidly in size, giving rise to the form shown in fig. 26. The shape of the whole shell is very similar to *C. pirothi*, but without

the marked carination of this species. It is fairly common in both lakes, and often occurs by itself, though it may be found with the normal type.

Though generally without any carination a single, rather feeble ridge may be developed on the upper whorls (fig. 27). It is possible that this is an uncarinated form of *C. pirothi*.

Pallary gives a number of species and varieties some of which, such as var. *pulchella*, might be applied to the fossil forms. It seems, however, better to regard them all at present as variations of *C. bulimoides*.

C. bulimoides occurs in both lakes and is wide spread. It is perhaps commoner in the Palaeolithic lake, and is rarely found with the typical Neolithic 'rocky' assemblage. On the other hand it is more frequent at the lower levels of the Neolithic lake than *C. pirothi*.

Cleopatra bulimoides cf. var. richardi Germain.

(Plate III, figs. 28-32.)

1911. *Cleopatra bulimoides* var. *richardi* Germain : *Doc. Sci. Miss. Tilho*, II, p. 40, pl. II, figs. 5-6.
1916. *Cleopatra bulimoides* var. *richardi* Germain : *Miss. Tilho, Seconde Notice*, p. 305, pl. I, figs. 3-4.
1930. *Cleopatra bulimoides* var. *richardi* Germain : Connolly, *Non-Marine Moll. of S. W. Africa. Ann. S. African Mus.*, XXIX, p. 321.

There is one variant of *bulimoides* that warrants special mention. This is a small elongated shell, with very convex whorls increasing gradually in size. It was only found in one locality, in sandy beds belonging to the Neolithic lake. There, however, it occurred abundantly and unmixed with any other species of *Cleopatra*.

In size and shape it very clearly resembles the Lake Chad var. *richardi* of Germain (1916), but without the carination of some of the spire whorls given in his description. Since, however, the type originally described by Germain did not show carinæ, the Faiyum shell may be regarded as this variety, though slightly smaller than the West African forms.

Besides the Lake Chad area, the only other locality known at present is in Ovamboland, South West Africa (Connolly).

Cleopatra pirothi Jickeli.

(Plate III, figs. 17-22.)

1881. *Cleopatra pirothi* Jickeli : *Jahrb. d. Deutsch. Mal. Ges.*, p. 338.
1888. *Cleopatra emini* Smith : *Proc. Zool. Soc.*, London, p. 54, fig. 2.
1927. *Cleopatra pirothi* Jick. : Pilsbry and Bequært, *op. cit.*, p. 298.

This *Cleopatra* is distinguished from *C. bulimoides* by the more acute spire, the more rapid increase in size and greater number of whorls (8 as against 6) and the invariable presence of one to three keels on the whorls including the last one. The part below the carina is almost vertical, giving rise to a very abrupt change of slope at the keel itself. Apart from the differences in shape already mentioned, this feature serves to distinguish the two species, since the change of slope in the carinated *bulimoides* is much less abrupt owing to the outward slope of the area below the keel.

C. pirothi is an Abyssinian and East African shell, and has not been recorded as living in Egypt or the Sudan, though Pallary mentions a bicarinate *bulimoides*, which, however, he does not regard as the same as *pirothi*.

The chief variations in the modern forms is in respect to the number of keels. Jickeli gives 2 as the usual number, but mentions also specimens with 1 or 3.

Martens (1886) made the form with one carina into a distinct variety *unicarinata*, from the Edwa Bank, while Blanckenhorn (1901) in his list from the same locality gives a variety *multicarinata*.

There seems little point in these varietal names, as any one assemblage of *pirothi* may show a few shells with 1, 3, 4, or even 5 keels (fig. 22), the majority having 2 (fig. 18).

Though occurring in the Palaeolithic lake *C. pirothi* is far more abundant in the Neolithic, where it is one of the most typical shells.

It is generally found in sands, and often in rocky habitats associated with *Unio* and *Etheria*.

Though occurring occasionally at low levels it is far more characteristic of the higher, particularly about 10 m.

Genus : **MELANOIDES** Olivier 1804 (= **MELANIA** Lam.).

Melanoides tuberculata (Müller).

(Plate III, figs. 1-16.)

1774. *Nerita tuberculata* O. F. Müller : *Verm.*, II, p. 191.
1804. *Melanoides fasciolata* Olivier : *op. cit.*, p. 69. *Atlas*, II, pl. XXXI, fig. 7.
1874. *Melania tuberculata* Müll. : Jickeli, *op. cit.*, p. 251, pl. III, fig. 7, pl. VII, fig. 36.
1909. *Melania* (*Melanoides*) *tuberculata* Müller : Pallary, *op. cit.*, p. 67, pl. IV, figs. 23-25.
1916. *Melania* (*Melanoides*) *tuberculata* Müller : Leiper, *op. cit.*, p. 153, text fig. 81.
1927. *Melanoides tuberculata* (O. F. Müller) : Pilsbry and Bequært, *op. cit.*, p. 256, pl. XXI, figs. 1-7.

This common African species is found in all Faiyum lakes at all horizons and in all types of deposit.

Its distribution outside of Africa into Asia and Madagascar is well shown by Pilsbry and Bequært (Map 2, p. 253). Its comparative absence from the west side of Africa south of the Sahara is remarkable as there appear to be no barriers to its distribution.

In the Nile, the Swedish Zoological Expedition (Hägg. 1904, p. 7) recorded it from mud at a depth of 1 m.

In the Faiyum the main interest centres in the variation of size. In most deposits the shells average from 15-18 mm. in length, but at certain horizons the *Melanoides* are exclusively small, slender shells, the largest measuring 15 mm., while the average is from 10-12 mm. (figs. 12-16). It may be that here again, as in the case of the low level *Theodoxus*, physical conditions caused a concentration of one size, but it is found more commonly than in the Theodoxids, and never with any sign of large forms intermixed.

The areas and levels at which this type occurs are as follows :

(1) North Faiyum. In cracks in and below scarp north of L' Basin in moderately fine, very clean sand at 20 m.

(2) Edwa Bank. West of Bats, below coarse gravel — 19 m. — here there are very rare fragments of larger *Melanoides*.

(3) West Faiyum. North side of sand and gravel bank — 18 m.
(4) Near Seliyin, in fine sand at about 15 m.

By far the largest specimens were found at low levels in Moeris Bay, and particularly in the small depressions between the foot of the last Tertiary scarp and the recent lake, which have obviously, in relatively modern times, been filled with water. These, though only a few square metres in area, seem to have bred enormous *Melanoides* (figs. 1-3). In one such situation in the north west the series figured were collected, the largest being 43.9 mm. in length and 14 mm. max. breadth; 9 whorls remain but the apex of the spire is broken. The largest *M. tuberculata* figured by Pilsbry and Bequært (p. 257) from Lake Edward is 25 mm. long and 7.5 mm. in diameter, while the maximum dimension recorded by Jickeli is length 41 mm. breadth 12 mm.

Here, then, there seems to be in the Faiyum a definite increase in size as the lake became smaller.

According to Pallary (1909, p. 67) a variety with a small spire is found at Damietta, and a similar form is also living at the present day in Tunis and Algeria. This lends support to the idea that the slenderer Faiyum forms may be a distinct race. Further the *Melanoides* from Albert Nyanza are all small, though not quite so slender as the Faiyum shells.

Family : **HYDROBIIDÆ.**

Sub-family : **Bithiniinæ.**

Genus : **BITHYNIA** Leach 1818.

The *Bithiniinæ* are at the best of times a difficult family and their determination when sub-fossil is far from easy. The operculum which is used in identification in some species is often absent, and no help is to be had from soft parts. For these reasons the definition of the following species from the Faiyum lake beds, though clear enough in some cases, may not be complete or final.

The collection of further material has already made it evident that *Bithynia badiella*, listed in the author's first paper (1927, p. 392), is not represented.

The new *Bithynia, B. connollyi*, may quite well be a *Hydrobia*, not a *Bithynia* at all, there is at present no means of settling the problem. There seems, however, little doubt that it is really new, to whichever genus it is assigned.

Bithynia connollyi Sp. N.

(Plate III, figs. 33-63.)

Description.—Shell of fair size, acuminate ovate, thin, corneous, bleached colourless. Spire produced, sides regular, apex sub-mamilate. Whorls 5 1/2, markedly convex, rounded at the periphery, regularly increasing, first 1 1/2 practically smooth, remainder sculptured with faint, close, regular, straight, vertical striolæ, suture simple, impressed, oblique. Aperture oval, peristome simple, acute, continuous but not free, outer lip straight and vertical in profile, upper columellar margin scarcely reflexed, forming a minute rima. Operculum unknown.

Long. 8.8, lat. 4.7, ap. alt. 3.3, lat. 2.6 mm.
Last whorl 5.1 mm.

Habitat.—Faiyum Depression, Tamiya Bank, south wadi (type).

Type in author's collection. Plate III, figs. 40, 59, 60. It appears to be distinguished from all other species by the great convexity of the whorls, combined with the deep, oblique suture and elongated spire.

The type has been chosen from the south Tamiya Bank, partly because the shells are very abundant and well preserved, and partly because the conditions of deposition seem there to have been quite normal. In the Edwa Bank the heavily lime charged water of the calcareous series may have produced modifications in the typical forms.

Variations.—From the most common form in all localities, which has been chosen as the type, variation in two directions takes place. In the first (figs. 34, 36, 50), and less frequent of the two, the tendency is towards shortening and broadening, the last whorl being proportionately larger and

the spire shorter. The whorls, however, retain the characteristic convexity and there is little doubt that such specimens as fig. 34 are but modifications of the type, since all intermediate shapes can be traced.

The second variation is in the opposite direction towards increase in length proportionately to the breadth, giving rise ultimately to the form shown in fig. 63 ($\times 1\frac{3}{5}$). This might be called the '*Hydrobia*' tendency, since the resulting shell resembles that genus much more closely than *Bithynia*.

The extreme of this variation is not very common, but intermediate stages are abundant, particularly among the shells of the 22 m. bank in the west of the depression. A series from this locality is shown in figs. 49-58. The first of these (fig. 49) is partially fossilised, being filled and hardened by calcareous matter.

Similar variations are found to a lesser extent among the specimens from the Edwa Bank (figs. 33-39) and the Tamiya Bank (figs. 40-48).

The above mentioned localities are the places where this species is most abundant. A few specimens have been found in the north, in Palaeolithic lake deposits. It does not occur at all in the Neolithic lake.

This shell, which is an abundant and characteristic Palaeolithic type, was first noted by Martens (*op. cit.*, p. 127, 1886) in his description of Schweinfurth's collection from the Edwa Bank. He there labels it *Bithynia* (or *Hydrobia*?) and thought that it resembled the south Italian *B. boissieri*, but that it was more slender, had a deeper suture and aperture only 2/3 the total length. He did not describe it either then or later.

In the palæontological collection at Berlin some of Schweinfurth's material from the calcareous series to the east of the Bats (see p. 90) was labelled by Martens *Hydrobia* sp. an nov.? These specimens were identical with others in the systematic collection labelled by Blanckenhorn *Bithynia* sp. nov. (figs. 64-67), and also with the specimens collected by the author from the same locality for which no counterpart could be found in the malacological collections of either the British Museum or Berlin.

This would seem to establish without doubt that the form now described is really the shell mentioned first by Martens, but never given a specific name by him. The author has very great pleasure in now naming it after Major M. Connolly, in token of his valuable help.

Bithynia senaariensis (Küster).

(Plate III, figs. 78-80 ($\times 1\frac{3}{5}$).)

1852. *Paludina senaariensis* Parreyss : Küster, *Conch. Cab.*, p. 44, pl. IX, figs. 10, 11.
1874. *Bithynia sennariensis* Parr. : Jickeli, *op. cit.*, p. 245, pl. VII, fig. 32.
1909. *Bythinia (Gabbia) sennaarica* Parr. : Pallary, *op. cit.*, p. 66.
1916. *Bythinia (Gabbia) sennaarica* Parr. : Leiper, *op. cit.*, p. 183, fig. 79.
1927. *Bulimus senaariensis* (Küster) : Pilsbry and Bequært, *op. cit.*, p. 216.

This shell is common in the Nile at the present day, and seems to be distinguished from other Egyptian species by its larger size — maximum length 9.5, breadth 5.75 mm., rather short fairly broad spire, suture moderately deep, whorls fairly convex, last whorl large.

It is easily distinguished from *B. connollyi* by the shorter, blunter spire and less convex whorls.

According to Jickeli the smaller forms are broader in comparison with their length than the larger shells. This makes it sometimes difficult to identify the smaller types, which tend to approach *B. goryi* in general shape. The operculum of *B. senaariensis* is supposed to be distinctive, but it is hardly ever found in the Faiyum deposits.

The shell is fairly common in both the Palaeolithic and Neolithic lakes in fine sands or clays. It has not so far been found at the low levels in the Neolithic lake.

Bithynia goryi Bgt.

(Plate III, figs. 74-77 ($\times 1\frac{3}{5}$).)

1852. *Paludina decipiens* 'Ferr.' : Küst., *Conch. Cab.*, p. 35, pl. VII, figs. 27-29.
1856. *Bithynia goryi* Bgt. : *Amén. Malac.*, I, p. 185.
1874. *Bithynia goryi* Bgt. : Jick., *op. cit.*, p. 244.
1909. *Bithynia goryi* Bgt. : Pallary, *op. cit.*, p. 65.

This is another Nile type of the present day. It is smaller than *B. senaariensis*, the maximum length being 7 mm., breadth 5.3 mm. According to the figures given by the above authorities the ratio of the length of the aperture to the total length is greater for *B. goryi* than for *B. senaariensis;* also

the whorls increase rather more gradually in *B. goryi*. These features together with the smaller size of the present species, serve to distinguish the two.

The Faiyum forms on the whole agree fairly well with the modern. There is, however, in some a greater tendency to elongation, giving a rather slimmer shell than the type.

It is one of the commonest Faiyum Bithynias, and is found in both lakes. In the Neolithic it is particularly abundant between 10-18 m. in fine sands with *Theodoxus, Cleopatra,* etc.

Bithynia neumanni (Mts.).

(Plate III, figs. 84-86 (× 1 $\frac{3}{5}$).)

1897. *Bythinia (Gabbia) neumanni* Martens : *Besch. Weichthiere Deutsch. Ost. Afrikas*, p. 191, pl. VI, fig. 33.
1911. *Bythinia (Gabbia) neumanni* Marts. : Germain, *Doc. Sci. Miss. Tilho*, II, pp. 40-41, pl. II, fig. 34.
1927. *Bulimus neumanni* (E. v. Martens) : Pilsbry and Bequaert, *op. cit.*, p. 216.

This *Bithynia* has not before been recorded from Egypt, its present habitat being Abyssinia and West Africa.

Specimens collected by Neumann from the Massai Steppe—the type locality—were examined in Berlin. They bore very little resemblance to the Faiyum species given this name, being much larger (maximum length 5.7 as against 3.1 mm.) fatter shells. The aperture, the sutures, and the amount of convexity of the whorls were, however, similar. On the other hand the Faiyum shells agree very closely with specimens from N' Gollom in the Connolly collection cited above by Germain, and therefore this name has been adopted for them. Both these and the N' Gollom shells must, however, if they are really *B. neumanni*, represent a smaller and narrower race of that species.

The possibility of their representing a juvenile stage of one of the larger Bithynias was carefully considered both for this and the next species. Apart from the fact that the shells appear to be fully grown in both cases, the character of the whorls and the suture are quite unlike those of either *B. senaariensis* or *B. goryi*. There is, however, a certain resemblance to *B. connollyi*, but the possibility of either or both of the small forms being the young of that

species seems definitely ruled out by the fact that both occur in the northern Faiyum in the Neolithic lake deposits, where there is no trace of the adult *B. connollyi*.

This point has been treated in some detail since questions of the migration of species is involved in the presence in northern Egypt of these two small Bithynias, whose present home now lies so far to the south.

B. neumanni is not common, but occurs in both lakes chiefly in sandy deposits. It is found in all the banks, the Edwa, Tamiya, and the 22 m. western one.

Bithynia tilhoi. Germain.

(Plate III, figs. 81-83 (× 1 $\frac{3}{5}$).)

1912. *Bythinia tilhoi.* Germain : *Bull. Mus. Paris*, p. 322.
1916. *Bythinia tilhoi.* Germain : *Miss. Tilho. Seconde Notice*, p. 306, pl. I, figs. 5-6.
1927. *Bulimus tilhoi.* (Germain) : Pilsbry and Bequaert, *op. cit.*, p. 216.

This is another small *Bithynia* (length 3.8 mm.), originally described by Germain from the Lake Chad region, and since discovered both in Abyssinia and Albert Nyanza.

The Faiyum shells agree very well with those from Albert Nyanza in the Connolly collection. They are, on the whole, slightly larger than *B. neumanni*, with a larger last whorl and more prominent aperture. The spire is also longer and more slender.

It is not common in the Faiyum, but is more widely spread than *B. neumanni* in the Palaeolithic lake. In the Neolithic, the species is found with *B. neumanni* in the higher levels associated with the typical fauna.

Both species appear to have died out at the lower levels.

Sub-Family : **Hydrobiinæ.**

Genus : **HYDROBIA** Hartmann 1821 (= **PALUDESTRINA** d'Orb.).

Hydrobia peraudieri Bourguignat.

(Plate III, figs. 123-134.)

1862. *Hydrobia peraudieri* Bgt. : *Moll. de l'Algérie*, p. 94, pl. V, figs. 12-15.

1901. *Hydrobia peraudieri* Bgt., var. *paladilhei* Tourn. : Pallary, *Moll. Algérie*, p. 165, pl. III, fig. 24.
1908. *Paludestrina peraudieri* (Bgt.) : Smith, *Proc. Mal. Soc.*, VIII, p. 10.

This species is given by Smith in the list of shells collected from the Birket Qarun by Dr. Cunnington. He states, however, that he is not certain that all the examples belong to the same species, since they show variation in form and in convexity of the whorls, etc. He further emphasises the difficulties of accurate determination, which are increased in fossil forms.

Hydrobia stagnalis var. *cornea* Risso, listed by Blanckenhorn from the Birket Qarun may according to Smith be the same species as *peraudieri.*

On comparing the descriptions of the two shells given by Bourguignat for *peraudieri* and *stagnalis* var. *cornea* by Jickeli (1874, p. 247) the differences are so great that it seems unwise to accept the two as identical.

The distinguishing features are as follows :

	H. PERAUDIERI.	H. STAGNALIS VAR. CORNEA.
Height	6-7 mm.	4 1/3 mm.
Diameter	1 1/2 mm.	2 mm.
Ratio Ht. : Diam.	1 : 4	1 : 2.1
No. of whorls	7 1/2	6
Suture	deep	moderately deep and scarcely oblique.
Aperture	round	oval, acute above.

It will be seen that *peraudieri* is a much longer, narrower shell than *stagnalis,* but whether the differences are greater than the normal variations in any one species is impossible to determine without investigation of much modern material.

In the Faiyum the Hydrobias seem to fall into two types : (1) long, narrow shells with a general resemblance to *peraudieri* (figs. 123-131) and (2) shorter, broader forms that might be classed as *stagnalis* var. *cornea* (figs. 132-134).

The agreement in either case it not exact. The larger types are found exclusively in one layer in the Tamiya Bank (p. 97). The height of these shells is from 6-7 mm., the suture is deep and distinctly oblique, and the number of whorls is 7. In these characteristics the shell agrees with *peraudieri.* It differs from it in being broader, 2 1/2 mm. as against 1 1/2 mm., and consequently having a much smaller height to diameter ratio, averaging 1 : 2.6. Further, the aperture is distinctly oval, not round.

Except for size it is very near to *H. peraudieri* var. *paladilhei,* which like the Faiyum species has flatter whorls and a more oval mouth, but is 9 1/2 mm. long.

It must be remembered, however, that the deposit of Palaeolithic age in which this *Hydrobia* occurs in great quantities also contains Lymnæas and *Pisidia* which show great variation and peculiarities of growth. It is, therefore, possible that the deviations from the type mentioned above are due to some external cause which tended to produce abnormalities in the fauna.

The second type is found in the lower deposits of the Neolithic lake, in the Birket Qarun, and also at the base of the Edwa Bank east of the Bats. It never attains the length of the Tamiya form, the largest measuring 4.6 mm., with a maximum breadth of 2 mm., giving a ratio of 1 : 2.3. This is an Edwa Bank form. One from low Neolithic levels has the following dimensions : height 4.3, breadth 2.0 mm., ratio 1 : 2.1.

The spire is not so elongated or so acute as in type (1), there are only 6 whorls as against 7, the suture is not so deep, and is decidedly less oblique. The aperture on the other hand is oval, and acute at the upper end.

Some types are even broader in proportion having a ratio of 1 : 1.3. These look so different from the elongated forms that it is difficult to place them in the same species.

The shorter forms resemble very closely *H. stagnalis* L. var. *acuta* Drap, from Montpellier in the Berlin Museum. The ratio of height : diameter in these shells is 1 : 2, and the number of whorls and character of the sutures is similar to that in type (2).

Hydrobia peraudieri is an Algerian shell, occurring in the Pliocene and Pleistocene deposits and still living at the present day, sometimes in extremely salt water.

Hydrobia stagnalis var. *cornea* is a brackish water form found, according to Jickeli, along the whole Mediterranean coast.

It is noteworthy that it was not found by Leiper in searching for shells in the fresh waters of the Nile. For this reason its presence in the Faiyum lake

beds is taken as respresenting brackish water. In the Neolithic lake it comes in at about 11 m. below sea level and is found right the way down to the modern lake; it is never found in any great quantity in these deposits.

In the Palaeolithic lake a few occur at the base of the Edwa Bank and in clays at lower levels to the north in the cliffs of the Bats Ravine.

The great abundance of them, however, is in the Tamiya Bank, in a bed which is described in detail later (p. 99).

Family : **VALVATIDÆ.**

Genus : **VALVATA** Müller 1774.

Valvata nilotica Jickeli.

(Plate III, figs. 135-136.)

1874. *Valvata nilotica* Jickeli : *op. cit.*, p. 233, pl. VII, fig. 29.
1884. *Valvata nilotica* Jick. : Innes, *Bull. Soc. Mal. Fr.*, pp. 346-347.
1909. *Valvata nilotica* Jick. : Pallary, *op. cit.*, p. 68, pl. IV, figs. 28, 29.

An Egyptian species found in the Nile and its affluents and common in both lakes and in all kinds of deposits in the Faiyum.

It is a small shell with a more elevated spire than *Planorbis* or *Segmentina*. There are typically 3 1/3 whorls, separated by a deep suture. The apex is obtuse, the aperture almost circular and the umbilicus large and deep.

It is stated to occur on water plants in canals and in pools between Suez and Cairo.

There is little to add to its description in the Faiyum. Its characteristics appear to remain fairly constant, it is common in the low level beds, and on the whole is more abundant in argillaceous than in arenaceous deposits.

Family : **NERITIDÆ.**

Genus : **THEODOXUS** Montfort 1810.

Theodoxus niloticus (Reeve).

(Plate III, figs. 87-122.)

1841. *Neritina nilotica* Reeve : *Con. Icon.*, IX, pl. XXXIV, fig. 157.
1899. *Neritina nilotica* Rve : Kobelt, *Iconographie N. F.*, VIII, pl. CCII, fig. 1317.

1909. *Neritina* (*Neritæa*) *nilotica* Reeve : Pallary, *op. cit.*, p. 68, pl. IV, figs. 30-33.
1924. *Neritina* (*Neritæa*) *nilotica* Reeve : Pallary, *op. cit.*, p. 35.

This species is common along the whole of the Nile, being particularly abundant at Aswan.

Its present generic name of *Theodoxus* is the result of the examination of the radula which differs from that of *Neritina*. The shell characters are, however, identical and therefore in fossil forms these two genera cannot be distinguished.

In the Faiyum this species is as a rule associated with sandy beds, being rare in the clays and loams. It is generally near the shore line of the time, and is far more abundant in the Neolithic than in the Palaeolithic lake, though in the clearer water deposits of the south side of the basin more are found at this horizon.

Like most of the lake forms it occurs in colonies, and if found at all, is found it considerable numbers.

Variation.—The most conspicuous variations are concerned with general shape, marking and colour, but in any one colony both shape, ornamentation and colour tend to a general similarity.

(1) *Shape.*—The commonest shape for the adult shell is more or less conical; that is, there is a tendency for elongation of the last whorl, the outer lip sloping down at a very acute angle to the columella, and keeping this direction almost to the base. This gives the shell the appearance of a truncated cone when viewed in its dorsal aspect, with a broad, rounded and oblique base and very short, obtuse spire (pl. III, figs. 87-106).

This form is most marked in the larger shells of any one colony, the smaller ones being frequently sub-globose.

In the second type of variation in this character the shell is much more rounded, being sub-globose when looked at from the back. The outer lip leaves the shell at a less acute angle and bends out in a curve of low arc (pl. III, figs. 107-114). Shells of this type occur as small forms with the sub-conical shapes, but may also be found among larger specimens, when

they tend to be exclusively of this type. In the two instances noted in the Faiyum both occurred under rocky limestone ledges near the shore line.

(2) *Ornamentation.* — The commonest markings found are more or less wavy oblique axial stripes of varying thickness. The stripes may be broad and relatively few, or narrow and numerous, but here again in any one colony the same kind of stripe is dominant (figs. 87-106).

Broad striped types were found in soft, white sand at levels between 15-9 m., the thinner banded forms in yellowish or crimson coloured sand in one case at 13 m. and the other about 7 m.

The broader striped form is the commoner (figs. 87-100). The amount of undulation in the stripe varies greatly, not only in one colony, but in one shell, in some cases marked and sudden bends occur, in other the stripe is not in a continuous line across the shell, and yet again the direction may vary in one and the same shell, giving rise to the appearance of an 'unconformity'.

In the broader striped types the spacing of the bands, also, shows great variation in different and the same individuals.

The forms with sharp bends in the stripes lead on to the next variation in this feature, which is found in the extreme zig-zagging of the bands, accompanied by a reduction in width (pl. III, figs. 107-114).

The incipient zig-zagging may be shewn in the broad forms, the extreme type together with the narrowing was never found in broad-banded colonies. It was almost exclusively confined to the two occurrences under rocky ledges, which also produced the large rounded shells. In these colonies no wavy types — either with broad or narrow stripes — were found, though the spacing and number of zig-zagging bands varied considerably.

(3) *Colour.* — The 'fashionable' colour is undoubtedly black stripe on white or pale yellowish ground which is found predominantly in the wavy striped variations.

In the broad-banded variations, however, a few shells have a dark purple stripe, while one individual shows black in the spire and the early part of the body whorl, but ends with stripes of distinct purple.

The greatest variety in colouring is shown in the shells from the two limestone ledges; various shades of purple predominate, but a few have deep

pink stripes, and one or two black. In these as in other cases the differences of colour may be due to different states of preservation.

Since all the peculiarities both in shape, ornamentation and colour, occur in shells associated with a distinct habitat — the limestone ledges — it seems probable that these variations are a response to the particular conditions obtaining there; that the fundamental type for the Faiyum lakes is a subconical, black and white, wavy striped shell from which the others were derived.

From a study of modern forms Pilsbry and Bequært (p. 160) are of the opinion that the oblique axial stripes are the ancestral pattern of the *Neritinæ*. It is, therefore, of interest to find that these Pleistocene shells of the Faiyum bear out this verdict.

The Theodixids of the last stages of the Neolithic lake tend on the whole to show more variation of colour than the standard types at higher levels, there is also more variety in marking in any one colony, and a great abundance of small shells (figs. 115-122). This last feature may be due to the increased salinity of the waters, but may equally be due to conditions of accumulation, since normal sized individuals are also found at the same levels. In favour of the former hypothesis is the fact that the *Neritinæ* are frequently found in the brackish water of estuaries, and therefore it would be expected that the Faiyum form would be able to adapt itself to change in this direction.

PELECYPODA.

Family : UNIONIDÆ.

This family in Egypt is in a state of confusion, thanks to Bourguignat, who gave a different name to every variety of shape that he found. Pallary in his Supplement (1924, pp. 42-52) divides it into sections, each with several species, but he admits that the family is at present not well enough known from the upper reaches of the Nile to give a satisfactory basis for classification. In pls. III and IV he reproduces several of Bourguignat's types.

A number of the Faiyum shells can be quite satisfactorily matched with some of these as far as shape and hinge character are concerned; but as the determination of living shells seems to depend largely on the colour of the nacre and character of the epidermis — features generally missing in fossil forms — difficulty in identification is very greatly increased.

For this reason, and until the living species have been properly worked out it has seemed safer to avoid the use of a multiplicity of names, such as *Unio gaillardoti, Unio anergus*, etc., and keep to a few apparently fundamental and old established types. On this basis there are five Faiyum Unios. Two of these — the extinct *Unio fayumensis* (=*schweinfurthi*) (pl. V, figs. 10-16) and *Unio teretiusculus* (pl. V, figs. 1-5) are quite distinctive. The other three fall into two groups with regard to shape : (1) those in which there is a definite broadening towards the posterior end of the shell; (2) those in which there is either a narrowing in this direction, or a general parallelism between the dorsal and ventral margins.

In pl. IV these two groups have been figured side by side, group (1) on the left under the type of *Unio egyptiacus* which also shows this character, and group (2) under the type *Unio niloticus* with more or less contrary features.

In group (1) are *Unio egyptiacus* (pl. IV, figs. 2-9), *Unio parreyssi* var. *petrettinii* (pl. IV, figs. 10-13), and in group (2) only *Unio niloticus* (pl. IV, figs. 15-22).

Genus : **CÆLATURA** Conrad 1853.

Cælatura egyptiaca (Cailliaud).

(Plate IV, figs. 1-9. Plate V, figs. 6-9.)

1823. *Unio egyptiacus* Cailliaud : *Atlas*, II, pl. LXI, figs. 6-7.
1827. *Unio ægyptiacus* Cailliaud : *Voyage à Meroé*, IV, p. 263.
1874. *Unio ægyptiacus* Fér. : Jickeli, *op. cit.*, pp. 271-273, pl. X, figs. 1-9.
1909. *Nodularia ægyptiaca* Fér., Caill. : Pallary, *op. cit.*, pp. 78-79, text fig. 8.
1914. *Nodularia ægyptiaca* Caill. : Simpson, *Cat. Naiades*, p. 1019.
1924. *Unio ægyptiaca* Fér., Caill. : Pallary, *op. cit.*, pp. 44-45.
1927. *Cælatura ægyptiaca* (Cailliaud) : Pilsbry and Bequært, *op. cit.*, p. 406, text fig. 89.

Simpson gives the following description of this species :

"Shell irregularly elliptical, subinflated, usually rather thin, subinequilateral, beaks moderately high and full, sculpture subnodular, zig-zag ridges, sometimes sharp or elevated pustules; dorsal line curved, anterior end narrowed and rounded; basal outline curved, fuller behind the middle; dorsal slope obliquely truncated, posterior ridge surface with irregular growth lines. Teeth lamellar pseudo-cardinals, one in left valve, two in the right. Laterals two in left, one in right. Muscle scar shallow, nacre bluish.

Length 42. Height 29. Diameter 19 mm."

It will be seen that figs. 2-9, pl. IV all fit this description reasonably well, and also the figure of Cailliaud's type (fig. 1), having due regard to the much smaller size of the Faiyum specimens.

They differ among themselves and from the type to a small extent. Figure 6 shows a shell with a smaller umbo than the rest, figure 8 one with a more curved hinge line and a slightly more anterior umbo. It agrees very well with Bourguignat's figure of *U. gaillardoti*, mentioned above, but for the reasons there given and also because it is a single specimen this name has not been adopted.

The greatest variation, both from these forms and from the type is seen in pl. V, figs. 6-9. The shell is here markedly shorter, deeper and more globular, the hinge line is more curved, the teeth much stronger and the muscular impressions much deeper. From these characters it may be questioned why this shell is classed as *egyptiaca* at all? It still retains, however, the characteristic posterior broadening and approaches in shape the shell in Jickeli's pl. X, fig. 5, and also some specimens of *egyptiaca* from Uganda in Major Connolly's collection.

Jickeli specially emphasises the very great variation found in this form — indeed he regarded *U. niloticus* as conspecific. Further, the chief modifications that he noted are in exactly the same direction as those in the Faiyum shells, namely, the gradual division of the cardinal tooth of the left valve until two fangs develop forming a fairly broad projecting tooth, and the shortening of the anterior part with a corresponding strengthening and shortening of the teeth.

By far the most pronounced variant in this direction is that shown in pl. V, figs. 6-7. It is a thick, heavy shell, markedly bigger than any of the other *egyptiaca*, and very much higher. It was found together with *Mutela dubia* and *Unio teretiusculus* in a sand, probably belonging to the Palaeolithic lake, on the eastern plateau just east of a IV Dynasty Kom (see map).

The remarkable feature of this assemblage is that *all* the shells share the thickening and heaviness of the *egyptiaca*. This is seen in pl. V, figs. 1-2, where the heavy *U. teretiusculus* from this locality is placed over the normal form for comparison.

The thickness and rounded shape of *egyptiaca* would offer a better resistance to wave and current action than the normal form; it is significant in this connection that the deposit in which they occur lies at the mouth of a modern wadi draining into 'L' Basin, and it is tentatively suggested that the peculiarities of this fauna are due to a similar position in past times.

The smaller *egyptiaca* (pl. V, figs. 8-9) while approaching the larger in shape differs in having a thin shell. It was found together with many normal examples wedged into the cracks of what must have been a rocky island in the Neolithic lake. Such a situation is a common one for all the bivalves, though they were also found in numbers in sands, not associated with rocks.

The other rounded types mostly occurred in sands, though in one case they were associated with white clays. No definite relation to a wadi could be traced in these cases, though some of the positions suggested from their level that they were near the shore line of the time, and may therefore have

been subjected to greater wave action than others. It is notable, however, that the extreme thickness and heaviness is found only in the IV Kom shells.

The remarkable smallness of the Pleistocene forms (maximum length 33 mm. as against 60 mm. of the type) may possibly be due to insufficient collecting and the chances of preservation, or it may be part of the general tendency for diminuition of size of all the fauna as compared with living types (see p. 103). It may be that the smallness is a peculiarity of the Faiyum lakes, as is the case with certain modern lake faunas. This point can only be settled when shells of corresponding age from the Nile Valley are described.

Cælatura nilotica (Cailliaud).

(Plate IV, figs. 14-22.)

1823. *Unio niloticus* Cailliaud : *Atlas*, II, pl. LXI, figs. 8-9.
1827. *Unio niloticus* Cailliaud : *Voyage à Meroé*, IV, p. 263.
1909. *Nodularia* (*Cælatura*) *nilotica* Cailliaud : Pallary, *op. cit.*, p. 77; pl. V, figs. 1-2.
1914. *Nodularia nilotica* Cailliaud : Simpson, *op. cit.*, p. 1020.
1924. *Unio* (*Iaronia*) *niloticus* Cailliaud : Pallary, *op. cit.*, p. 49.

Comparing Cailliaud's figures of his two species *Unio egyptiacus* and *U. niloticus* (pl. IV, figs. 1 and 14) the fundamental distinctions may be tabulated as follows :

(1) The dorsal and ventral margins in *U. niloticus* are almost parallel, giving a fairly regular oval outline, while in *U. egyptiacus* there is a marked divergence from the anterior to the posterior end.

(2) The umbo in *Unio niloticus* is both more prominent and more anteriorly placed than in *U. egyptiacus*.

(3) The anterior muscle impression is deeper in *U. niloticus* than in *U. egyptiacus*.

It is on these characters, but particularly the first, that the Faiyum shells have been classified. The degree of similarity to the type can be seen in pl. IV.

As in *egyptiaca* some of the Pleistocene forms match various figures of Bourguignat's (Pallary 1924, pl. III) as for instance *U. pruneri* and *U. anergus*,

but no good purpose would be served by adopting these names at the present stage.

The Faiyum *nilotica* do not show so much variation as the *egyptiaca*, the size is also on the whole greater. The shell is thicker in all specimens than in the majority of *egyptiaca* — a feature also found in the modern forms — and the ornamentation less marked, though the growth lines are generally stronger. The surface is, however, so frequently worn that little reliance can be placed on this character.

It is notable that the *nilotica* with the thickest shell and heaviest cardinal tooth (pl. IV, fig. 21) comes from a coarse gravel deposit in which the other bivalves also show the same tendency to thickening. Since there must have been considerable movement for the deposition of the gravel, this fact bears out the evidence obtained for *egyptiaca*, where the variation is in the same direction.

Apart from the last mentioned form the rest of the shells figured were found in clays, either near Seila or in the Wadi Nazla.

They seem to be the predominant type in the west and south, being quite rare in the north, where *egyptiaca* is the commonest species.

Cælatura parreyssi var. petrettinii (Bourguignat).

(Plate IV, figs. 10-13.)

1924. *Unio parreyssi* (v. de Buch) Philippi, var. *petrettini* Bgt. : Pallary, *op. cit.*, pp. 46-47, pl. III, figs. 16-18.

This shell, according to Pallary, is intermediate between *egyptiaca* and *nilotica*. Since it seems to show fairly constant distinguishing features it is dealt with separately here.

Like *egyptiaca* there is a distinct posterior broadening, though not to quite the same extent. This is due mainly to the greater breadth at the anterior end.

It resembles *nilotica* in the position of the umbo, which, however, is not so prominent.

The hinge line is more curved than in *egyptiaca*, though it is like this species in the thinness of the shell.

The depth of the muscular impressions is intermediate between *egyptiaca* and *nilotica*.

It is a rare shell in the Faiyum, and was found only in one locality near Dimê, in sand between cracks in the rocks, and one larger thicker specimen in a fine gravel near Dimu, in the south of the depression. The first of these occurrences is Neolithic, the second Palaeolithic.

Genus : **UNIO** Retz., 1788.

Unio teretiusculus Philippi.

(Plate V, figs. 1-5.)

1847. *Unio teretiusculus* Philippi : *Abbild. Beschr. Conchyl.*, III, p. 45, pl. III, fig. 3.
1874. *Unio teretiusculus* Phil. : Jickeli, *op. cit.*, pp. 276-278, pl. XI, figs. 1-3.
1909. *Nodularia* (*Lanceolaria*) *teretiusculus* Philippi : Pallary, *op. cit.*, p. 79, pl. V, figs. 3-4.
1914. *Nodularia teretiusculus* Phil. : Simpson, *op. cit.*, p. 981.
1927. *Unio teretiusculus* Philippi : Pilsbry and Bequært, *op. cit.*, p. 386.

This shell is at once distinguished from the other Faiyum Unios by its comparatively greater length and lower altitude, together with the parallelism of the dorsal and ventral margins. The posterior end is pointed, the anterior regularly rounded. The cardinal teeth are triangular and compressed, there are two in the left and one in the right valve. It occurs throughout the Nile System, but not in Abyssinia or the Great Lakes. There are, however, two sets of specimens said to be from the Niger in the British Museum.

In the Faiyum it is a common and characteristic member of the Neolithic lake assemblage, being practically confined to the arenaceous beds; it also occurs in the Palaeolithic.

Most of the specimens are decidedly smaller than modern forms, with thin to moderately thick shells. In one instance, however, there is very great thickening of the shell, together with a strengthening of the cardinal teeth. The size is here also greater. These are the shells already referred to in describing the variation of *C. egyptiaca*, and are figured in pl. V, figs. 1 and 2. Similar shells were found nowhere else.

The three species which follow are quite distinct and the first two do not occur in the Faiyum, but their bibliography is appended in order to elucidate the third.

Unio parreyssi var. **schweinfurthi** Martens.

1876. *Unio parreyssi* var. *schweinfurthi* Mts. : *Novit. Conch.*, IV, p. 140, pl. CXXXII, figs. 3-5. Hab. A.-E. Sudan, Tonji River.

Unio willcocksi Bullen Newton.

(Plate V, figs. 17, 18.)

1864. *Unio lithophagus* (?) S. P. Woodw. : *Q.J.G.S.*, XX, p. 19.
1899. *Unio willcocksi* (= *lithophagus* Woodw., non "Ziegler" Phil.) Newton, *Geol. Mag.*, VI, p. 406, pl. XX, figs. 1-4.
1901. *Unio schweinfurthi* Mts. (= *dembeæ* Mts., non Rossm. and *wilcocksi* Newton) Blkhn., *Zeitsch. Deutsch. Geol. Ges.*, XII, p. 431.
1924. *Unio vignardi* Plry. : *Mém. Inst. Ég.*, VII, p. 40, pl. IV, figs. 16, 18.
Hab. A.-E. Sudan 2nd cataract (*lithophagus*). Egypt : Kom Ombo; Edfu; Sebil (*willcocksi*); Edfu (*vignardi*); Gebel Silsile (Schweinfurth).

Unio fayumensis Pilsbry and Bequært.

(Plate V, figs. 10-16.)

1883. *Unio cf. dembeæ* Rossm. : Mts., *Sitz.-Ber. Ges. Nat.-Fr.*, Berlin, p. 6.
1886. *Unio schweinfurthi* Mts. : *op. cit.*, p. 127.
1909. *Unio schweinfurthi* Bgt. : Plry, *op. cit.*, VI, p. 81.
1927. *Unio fayumensis* (= *schweinfurthi* Mts., 1886, non 1876) Pilsbry and Beq., *Bull. Amer. Mus. Nat. Hist.*, LIII, p. 381.

Shell triangularly ovate, fairly convex, solid, concentrically striatulate and marked with more distinct lines of growth; exact position of umbones destroyed, but protruding within from 2/3 to 3/8 of the length; anterior margin rounded, dorsal and ventral almost equally curved, posterior sub-rostrate; dorsal margin descending gradually from the umbones to the end of the lateral teeth, and thence obliquely sub-truncate; ventral margin hardly ascending behind.

Posterior area not very wide, indistinctly circumscribed. Cardinal teeth thick, in the right valve nearly single, in the left two almost equal. Posterior

lateral teeth slightly curved, equal in length to half that of the shell. Anterior muscular impression deep, accessory situated diagonally beneath and behind it. Pallial line nearly sub-circular.

Long. 43; alt. 32; diam. 23 mm.

The confusion existing with regard to this shell, as shown by the above bibliography, was originated by Martens, who compared both the Faiyum and Gebel Silsile shells with *Unio dembeæ*, and evidently considered the two fossil forms identical.

In 1886, however, he had come to the conclusion that the shortness of the Faiyum shell and general divergence in shape from *U. dembeæ* warranted a new name, and he accordingly called it *U. schweinfurthi*.

Blanckenhorn in 1901 perpetuated the error of regarding the fossil shell from Gebel Silsile as the same as the Faiyum form, although he compared the specimens in the Berlin Museum, collected by Schweinfurth from both localities. At that time the type of the Faiyum *schweinfurthi* had disappeared. The differences in the two shells, both collected by Schweinfurth, are shown in figs. 14-18, by the kindness of the Director of the Geological Museum.

Recently Pilsbry and Bequært have pointed out that Martens' name of *schweinfurthi* cannot be retained for the present species, as that author had already bestowed it on a variety of *U. parreyssi* ten years earlier; they accordingly re-named it after its locality.

So far as is known at present, *U. fayumensis* is confined to the Pleistocene beds of the Faiyum. Its nearest African ally appears to be *U. marteli* Pallary (1920, p. 156, pl. III, figs. 1-4), which is found in Morocco, both recent and fossil (Pleistocene). This form has, however, much weaker dentition.

In the Faiyum the distribution is very limited both laterally and vertically. It is fairly abundant in the type locality in the railway cutting east of the Bats Drain (see p. 87). A few were found in similar beds about 40 m. to the south, a very worn and broken specimen, probably derived, in an isolated outcrop of clays in the cultivation south west of Seila Station. West of the Bats it has only been found in one locality, namely in a rather coarse gravel forming a cliff, 400 m. south of the cutting. It is interesting to note that the specimens here (pl. V, figs. 12, 13) are rather larger than the eastern forms, which exactly resemble the shells in the Berlin Museum.

Outside of these localities the author has not found it either at the same or lower levels. It is entirely unknown from the Neolithic lake deposits.

Family : **MUTELIDÆ.**

Genus : **ASPATHARIA** Bourguignat 1885 (= **SPATHA** Auct. non Lea.).

Aspatharia rubens var. cailliaudi Martens.

(Plate V, figs. 19-20.)

1866. *Spatha cailliaudi* Martens : *Mal. Blätt.*, XIII, p. 9.
1874. *Spatha cailliaudi* Marts. : Jickeli, *op. cit.*, p. 259, pl. VIII, figs. 1, *a*, *b*, *c*.
1909. *Spatha rubens* var. *cailliaudi* Martens : Pallary, *op. cit.*, pp. 83, 84, text fig. 4.
1914. *Spatha rubens* var. *cailliaudi* Mts. : Simpson, *op. cit.*, p. 1316.
1927. *Aspatharia rubens* var. *cailliaudi* (E. v. Martens) : Pilsbry and Bequært, *op. cit.*, p. 422.

This is the largest of the Faiyum bivalves and is very common in the Neolithic lake, but less so in the Palaeolithic. It seems to have been a favourite article of food both for the Neolithic and later peoples, since many valves were found in their kitchen middens.

It is generally associated with arenaceous deposits.

The size of the shells is rather smaller than the majority given by either Jickeli or Simpson, though it equals that in Jickeli's figure.

It is of interest to note that the largest examples collected by Jickeli came from small pools near Cairo.

Dimensions of largest Faiyum shell :

Length 127 mm.; height 84 mm.; thickness 47 mm.

Aspatharia wahlbergi hartmanni (Martens).

(Plate VI, figs. 6-9.)

1866. *Spatha hartmanni* Martens : *Mal. Blätt.*, XIII, p. 10.
1874. *Spatha hartmanni* Jickeli : *op. cit.*, p. 263, pl. VIII, figs. 2 *a-c*.
1914. *Spatha wahlbergi* var. *hartmanni* Simpson, *op. cit.*, p. 1327.
1924. *Spatha hartmanni* Martens : Pallary, *op. cit.*, p. 54.
1927. *Aspatharia wahlbergi hartmanni* (Martens) : Pilsbry and Bequært, *op. cit.*, p. 423.

This is a much smaller, lower shell than *cailliaudi,* more elongated in form and more inequilateral. The dorsal and ventral margins are nearly parallel, especially in the young. The hinge line is only slightly curved, while the opposite margin is straight or slightly sinuate. The teeth are either absent or represented by faint horizontal lamellar ridges. Both the umbo and hinge line are poorly developed.

It is recorded only from the Upper Nile and Central Africa and does not appear to be living in Egypt at the present day.

According to some authorities it has a wider distribution, being identical with the South African *Aspatharia wahlbergi* (Krs.). It is also said to occur in West Africa. In the Faiyum the species was found in one locality only, on the east side of the Bats about 1 kilom. south of the line. It occurs in sand in the cracks of the Tertiary rocks below a projecting spur of older lake beds (p. 94).

Some of the shells bear at first sight a resemblance to *Chambardia locardi* (pl. VI, figs. 10-13). This is particularly true of the young of both species (figs. 9 and 10).

The two can, however, be distinguished by the following characteristics :

(1) The greater parallelism of the dorsal and ventral margins in *hartmanni* — there is a decided posterior widening in *locardi.*
(2) The umbo in *locardi* is more anterior than in *hartmanni.*
(3) The muscular impressions in *locardi* are deeper than in *hartmanni,* especially the anterior foot impressions.

Genus : **CHAMBARDIA** Bourguignat 1890.

Chambardia locardi Bourguignat.

(Plate VI, figs. 10-13.)

1890. *Chambardia locardi* Bourguignat : *Bull. Soc. Mal. Fr.*, VII, p. 310.
1909. *Chambardia locardi* Bgt. : Pallary, *op. cit.*, p. 84, pl. V, fig. 5.
1927. *Chambardia locardi* Bgt. : Gardner, *Geol. Mag.*, p. 394, text fig. 3.

This is a particularly interesting shell geologically, since it constitutes a definite link with the past history of the Nile Valley. It was discovered in

1877 by Dr. Chambard in the deposits of an old branch of the Nile at Ramses and Serapeum in Lower Egypt, and had not been recorded from other localities till found in the Faiyum Neolithic lake beds by the author in 1926. Though described and figured by Pallary among the modern Egyptian shells, it has not up to the present been found living.

Some of the outstanding characters have already been given above (p. 54) in the comparison with *Aspatharia hartmanni.* Here it need only be noted that the hinge, besides being more curved, is heavier than in *hartmanni,* and lamellar teeth ridges are generally more plainly marked. The dorsal margin is typically sinuous, though in the young it may be almost straight. The muscular impressions are deep. The size averages 60 mm. in length by 33 mm. maximum height.

In the Faiyum it has a very local distribution, being confined to the Neolithic lake and has only been found on the north side in three localities, namely : near Dimê at about 10 m. above sea level; on the rocky Neolithic island, already mentioned in connection with the Unios, south east of Camp II at 10-12 m.; and south east of 'L' Basin. In all these places it was in sandy deposits in the cracks of the Tertiary rocks, or under a rocky overhanging ledge.

It has not so far been recorded by Drs. Sandford and Arkell from the Nile Valley, and it will be of great interest if these gentlemen find a connecting link between the eastern Delta and the Faiyum at some intermediate point.

Genus : **MUTELA** Scopoli 1777.

Mutela dubia (Gmelin).

(Plate VI, fig. 5.)

1757. *Le Mutel.* Adanson : *Hist. Nat. Sénégal, Coquillages*, p. 234, pl. XVII, fig. 21.
1790. *Mytilus dubius* Gmelin : *Syst. Nat., Ed.* XIII, I, 6, p. 3363.
1914. *Mutela dubia* (Gmelin) : Simpson, *op. cit.*, p. 1353.
1927. *Mutela dubia* (Gmelin) : Pilsbry and Bequaert, *op. cit.*, p. 430, pl. XXXVIII, figs. 1, 1 *a*, 1 *b*, 2.

This species is a typical West African form, and although not recorded from the Nile itself it is known from Albert Nyanza and the River Aswa.

According to Pilsbry and Bequært it is more closely related to Nilotic than to Congo forms. It is, however, quite definitely distinguished from the Nile Mutelas by the very marked posterior broadening, with a corresponding anterior narrowing. As a consequence the posterior margin is broad and truncates the shell obliquely.

In searching the British Museum Nile Mutelas for a counterpart of the Faiyum form none could be found, since all the Faiyum shells show the features given above as characteristic of *dubia*.

Further, Simpson's description of *dubia* exactly fits the Faiyum forms, and when Major Connolly called the author's attention to Pilsbry and Bequært's figures and the shells in his own collection no doubt remained that the Faiyum types were really *Mutela dubia*.

This is of interest as showing once more a possible faunal connection with West Africa in Pleistocene times, and suggests the evolution in Egypt into the modern nilotic species while in the old lake beds the original West African type is preserved.

With further collecting, however, *M. dubia* may be found in the Nile, but it must in any case be rare, while in the Faiyum lake beds it is the only species represented.

It occurs in both lakes, but is more abundant in the Neolithic. It is always associated with sandy deposits, and seems much commoner in the north of the area.

In size it is comparable with modern forms as given by Pilsbry and Bequært.

Family : **ETHERIIDÆ.**

Genus : **ETHERIA** Lamarck 1807.

Etheria elliptica Lamarck.

(Plate VI, fig. 14.)

1807. *Etheria elliptica* Lamarck : *Ann. Mus. Paris*, X, pp. 401-402, pl. XXIX-XXXI, fig. 1.
1909. *Ætheria elliptica* Lamarck : Pallary, *op. cit.*, pp. 85, 86.
1914. *Ætheria elliptica* Lam. : Longstaff, *op. cit.*, p. 251.

1926. *Ætheria elliptica* Lam : Cox, *Fossil Mollusca. Geol. and Pal. of Kaiso Bone Beds. Geol. Sur. Uganda*, p. 67.
1927. *Etheria elliptica* Lam. : Pilsbry and Beq., *op. cit.*, pp. 449-455, pl. XLVI, figs. 1, 1 *a*, pl. XXX, figs. 2, 2 *a*.
1929. *Etheria elliptica* Lam. : Sandford and Arkell, *Or. Inst. Pub.*, X, p. 56.

According to present opinion there is only one species of Etheria in Africa, although the variation in different and in one and the same localities may be great.

A good map of the distribution of the genus in Africa, together with a description of its mode of occurrence is given in Pilsbry and Bequært's work.

In the Congo the species is found, often in great quantities, in the rocky parts of the river beds about rapids and falls. In the Upper Nile Mrs. Longstaff states that shells occur in such numbers as to impede navigation.

The main variations are in the surface ornamentation of the shell. Some are smooth, others have rows of tubes. An attempt has been made to correlate the tubiferous variety with quiet, and the smooth with rapidly-moving water. But according to Mrs. Longstaff and Pilsbry and Bequært both types may occur together in one colony.

In the Faiyum, the shells appear to be all of the 'tubifera' type, which so far as it goes, tends to support the above hypothesis since they presumably lived in quiet lake waters. They do not grow to any great size, neither do they occur in large colonies as in modern rivers.

They are, however, always associated with a rocky bottom and are generally found in the northern Faiyum in the same localities as *Chambardia* and the Unios and Mutelas, when these occur in rocky localities.

Etheria has not been found by the author in the Palaeolithic lake beds of the north, or west. It has, however, recently been recorded by Drs. Sandford and Arkell from the 28 m. level near the Hawara Pyramid in the south of the Oasis.

The statement by Pilsbry and Bequært (p. 447) that fossil forms of *Etheria* are not known, except from "supposedly Pleistocene deposits in Lower Egypt" does not hold good. It refers presumably to the occurrence of *Etheria* together with *Chambardia* in the eastern Delta, but the genus has also been found fossil in the younger Diluvium of the Nile (Blanckenhorn,

pp. 431-432, 1901) at 30 m. above river level, and from the Pleistocene of Uganda (Cox., p. 67), as well as from the Faiyum Pleistocene.

Family : CYRENIDÆ.

Genus : CORBICULA Mühlfeld 1811.

Four species of *Corbicula* are known from the Faiyum lake beds, three existing forms — *artini, consobrina,* and *africana* — and one apparently extinct — *vara.*

The latter, a species new to science, is interesting in its peculiar modification of shape, and in its extremely local distribution.

The new form will be described first, and after a short account of *consobrina* and *artini,* the relation of these three types will be considered.

Corbicula vara Sp. n.

(Plate VII, figs. 1-11.)

1929. *Corbicula innesi* Bgt. : Sandford and Arkell., *Or. Inst. Pub.,* X, p. 41.

Description : Shell comparatively small, tumid, isosceles in form, thick and solid. Surface with low, rather distant growth ridges of irregular strength, anteriorly markedly flat and broad, posteriorly only slightly arched. Ventral margin regularly rounded, making equal angles with the anterior and posterior edges. Umbones prominent, with a pronounced anterior twist. Hinge markedly thick and heavy and greatly curved, so that parts on either side of umbones if produced meet in an acute angle. Teeth of the usual corbiculid type, strong, with cardinals running obliquely backwards, lateral teeth straight or slightly curved, the posterior often straighter than the anterior.

The distinguishing features of this new species are the extreme narrowness of the shell, together with great tumidity, abnormal thickness and heaviness, especially in the umbonal region, and the marked twisting of the umbo.

The backward curvature of the cardinal teeth is not a distinctive feature, since it may occur in other *Corbiculæ,* and seems to be related to the degree of curvature of the umbo.

The shells are all bleached and most of them are more or less worn.

Corbicula vara is entirely confined to the Palaeolithic lake and mainly to the coarse 35 m. gravels of the south, south east, and west, where it is common. A few have been found in the Edwa Bank, but none at Tamiya, and it is curiously absent from the 22 m. bank in the west, though in the 30 m. gravels immediately above it is plentiful. It appears then to have become scarce and local at the 22 m. stage, and to have died out altogether at lower levels. It has so far never been found in the north.

The types (figs. 1, 8, 9), in the author's collection, were chosen to exhibit the distinctive features in both valves, but these are not pairs, and no united valves were found. They are both from the 30 m. gravels of the western Faiyum.

The size of the types is as follows :

	LENGTH.	HEIGHT.	THICKNESS.	UMBONE-HINGE THICKNESS.
	—	—	—	—
Left valve.....	15.5	19.7	8.3	6.9
Right valve.....	15.6	18.8	8.2	6.3

Other shells give the following measurements :

PLATE VII.	LENGTH.	HEIGHT.	THICKNESS.	UMBONE-HINGE THICKNESS.
—	—	—	—	—
	(All Single valves).			
Figure.				
2.....	13.7	17.2	8.2	6.2
3.....	14.2	17.7	8.0	6.0
4.....	17.2	21.2	8.5	7.1
5.....	8.8	10.9	4.5	3.7
6.....	12.2	10.0	5.0	4.2
7.....	14.5	17.5	7.0	5.9
10.....	12.8	15.3	6.5	5.3
11.....	14.6	17.2	7.5	5.6

When first found in 1926, a specimen was submitted to Dr. Hume, then Director of the Geological Survey of Egypt. He very kindly sent it to M. Pallary, the authority on modern Egyptian mollusca, who considered it to be *C. innesi* Bgt. It was therefore identified as such by Connolly for Dr. Arkell and appears under that name in his list of shells from the Faiyum (*op. cit.,* p. 41).

Since that time, however, specimens have been sent to Geneva, where M. Mermod kindly compared them with Bourguignat's type. He was also good enough to send a photograph of the type of *innesi* (pl. VII, figs. 43, 44) represented by a single specimen only. There can be no doubt that the two are quite distinct, and therefore a new name had to be found for the Pleistocene species. *Innesi* is simply *C. consobrina*.

It is interesting that Drs. Sandford and Arkell have not recorded the new Faiyum species from the adjacent parts of the Nile Valley. So far as the evidence goes it would appear to be entirely a local type, evolved in response to the peculiar conditions of the Palaeolithic lake, which are discussed in a later section (p. 74).

Corbicula artini Pallary.

(Plate VII, figs. 12, 15-22.)

1902. *Corbicula artini* Pallary : *Bull. Inst. Égypt.*, II, p. 93, pl. I, fig. 4.
1909. *Corbicula artini* Pallary : *op. cit.*, pp. 71, 72.
1930. *Corbicula artini* Pallary : Connolly, *Proc. Mal. Soc.*, XIX, p 43.

Corbicula vara seems to grade by the reduction of its typical characters into *Corbicula artini*.

This species according to Pallary is characterised by its thick shell, great height, almost equilateral form and large umbones. It is found in the Nile, but is rarer at Alexandria and Ismailia than higher up.

Figure 13, pl. VII, shows a form which in the author's opinion is intermediate between a typical *vara* and a typical *artini*. This does not imply any generic descent, for though such may exist, no proof of it has yet been found. The two types commonly occur together, and no vertical series was made out.

In the Faiyum, *artini*, unlike *vara*, was found in the northern 30 m. gravels and at lower levels, though it is not so common there as in the rest of the Oasis.

It will be seen from the figures that the difference between *vara* and *artini* is not one of age, since the young of both types keep their distinctive characters (pl. VII, figs. 5, 6 and 15).

Connolly has shown (*op. cit.*, p. 43) that *C. artini* bears extremely close relation to the Mesopotamian *C. fluminalis* Müll.

If this is so, there can be little doubt that the majority of the shells called *'fluminalis'* from the Pleistocene river gravels of England are not *fluminalis* at all, but *consobrina*, since they are typically much longer thinner forms than *artini*. This was realised by Searles Wood in one of the first descriptions of *Corbicula* in England — in this case from the Norwich Crag. He there names it *'Cyrena Consobrina'* Cailliaud (1850, II, p. 104, pl. XI, fig. 15) and compares it with Cailliaud's type figure.

It would seem, then, that the British Pleistocene *Corbiculæ* were derived from North African rather than Asiatic sources.

Corbicula consobrina (Cailliaud).

(Plate VII, figs. 25-42, 45-47, 48-49.)

1823. *Cyrena consobrina* Cailliaud : *Voy. à Meroé*, II, pl. LXI, figs. 10, 11.
1874. *Corbicula fluminalis* Müll. : Jickeli, *op. cit.*, pp. 283-286, pl. XI, figs. 4-9.
1909. *Corbicula consobrina* Cailliaud : Pallary, *op. cit.*, p. 71, text fig. 2.

This species is characterised by its greater length compared with the other two, by the less prominent umbones and general greater lightness of the shell.

Judging both from the British and Berlin collections *consobrina* would appear to be much commoner in the Nile than *artini*.

In the Faiyum, also, it is on the whole the predominant form in both lakes, having a wider lateral and vertical distribution. In the northern 30 m. gravels it occurs in great numbers, and shows some interesting variations from the type.

The most striking of these is the tendency to greater length in comparison with the height, seen in figs. 41-42 in its extreme form. It is not a very common variant in the Faiyum and was only found in the north, but in the Connolly collection there is an even longer shell which occurred with more normal forms from the Sudan, and one or two fairly long shells among ordinary *consobrina* from Uganda. This type of variation is not new, since

E. A. Smith remarked on the great variability in shape of the modern shells collected in the Birket Qarun (*op. cit.*, p. 11). Indeed he considered that the extreme forms might well be regarded as distinct species.

The second noticeable feature in *C. consobrina* from the northern gravels is the greater prominence and thickness of the umbo as compared with the modern types in the Birket Qarun. (Pl. VII, figs. 48, 49.)

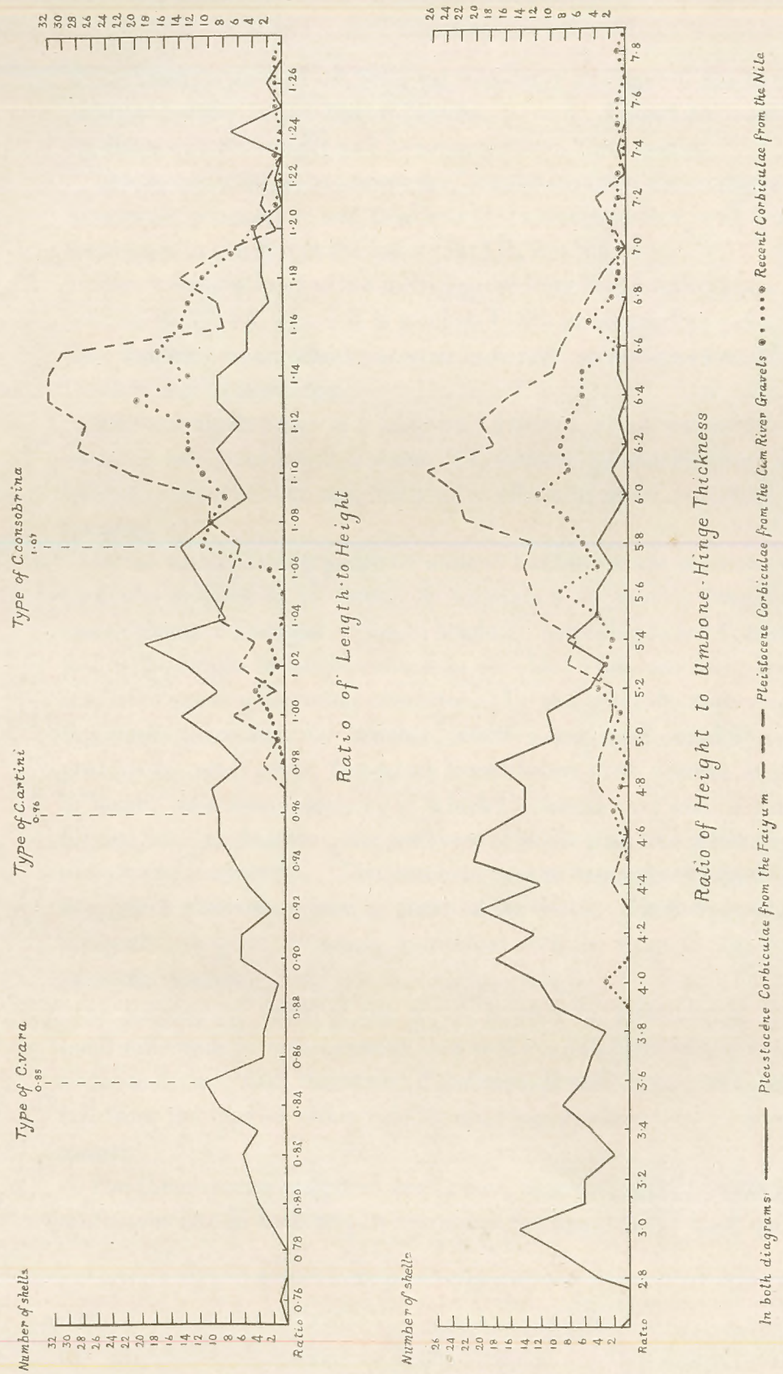
This is seen in most of the shells figured from that locality, but is especially marked in fig. 23, where it is combined with an unusually asymmetric form. This tendency to asymmetry is seen in several specimens (figs. 38, 40) and is not typical of *consobrina*.

All these shells occur in a fairly coarse gravel, which was probably deposited in no very great depth of water. The above peculiarities may be associated with this situation, and the greater effects of wave movement on coarse material.

In the accompanying graph an attempt has been made to compare as many *Corbiculæ* as possible in respect to two ratios — namely length to height and thickness of umbonal region to height. According to Dr. Prashad (1929, p. 50) the length to height ratio is so variable in any one assemblage that it is of little use as a diagnostic character. Up to a point the author agrees with this view; there are, for instance, shells which must certainly on general grounds be called *artini*, but which nevertheless show a much larger length to height ratio than usual, or in which the length may even slightly exceed the height. If, however, the numbers of shells with like ratios are plotted, some order is apparent. The numbers tend to concentrate round certain ratios, which therefore appear as peaks on the curve. Further, in several cases the peaks are quite, or nearly, coincident with the value for the type of the particular species.

In judging the value of the curves it must be remembered that a very small difference in measurement may make a difference in the second place of decimals, and that, therefore, if the concentration is only one point removed from the type on either side, it must signify shells very near the typical species.

The three species compared are *C. vara*, *C. artini*, and *C. consobrina*. The continuous line in both graphs represents the fossils shells from the Faiyum;



the broken line a representative selection of Pleistocene *Corbiculæ* from the Cambridge river gravels; and the dotted line modern African *Corbiculæ* from the British Museum, the Connolly, and the author's collections.

The most striking and interesting feature of both graphs is the general similarity of the curves for the British Pleistocene and modern African *Corbiculæ*. In both cases the curve attains the maximum considerably further to the right than in the case of the Faiyum fossil shells, and also extends further in that direction. On the other hand, in neither case is there any specimen in these two curves that even approaches the low ratios of the Faiyum new species.

Is it merely coincidence that the two most similar curves both belong, in the main, to shells from rivers, as opposed to the exclusively lacustrine habitat of the Faiyum specimens? The question cannot be answered without further work, but it came as a surprise that the two Pleistocene curves differed from each other to such an extent, and that the modern Egyptian types should be so similar in ratio to the British Pleistocene ones.

A second point that the Faiyum curve brings out is the distinctness of the new species. Not only are the ratios much lower than those for all other forms, but they show a good concentration around one point and are separated by a broad, low-lying area — i. e. one with few specimens — from *C. artini*. These few specimens must be regarded as intermediate forms, such as are figured in pl. VII, figs. 13-14.

On the other hand, *C. artini* and *C. consobrina*, two recognised species, are not separated nearly so clearly; there are obviously many more intermediate forms, though this may be partly due to the greater numbers collected.

There can, however, be little doubt that the whole series is continuous, and that forms may be found grading into the chief types, until finally such different end terms are obtained as the narrow, new species on the one hand, and the elongated variety of *C. consobrina* on the other.

Corbicula africana (KRAUSS).

(Plate VII, figs. 50-54.)

1846. *Cyrena radiata* "PARR." : PHIL., *Abb. und Beschr.*, II, p. 78, pl. I, fig. 8.

1848. *Cyrena africana* var. *olivacea* Krs. (= *radiata* Parr.) Krs., *Sudafr. Moll.*, p. 8, pl. I, fig. 8.
1908. *Corbicula radiata* (Philippi) : Smith., *op. cit.*, p. 11.
1927. *Corbicula radiata* (Philippi) : Pilsbry and Bequært, *op. cit.*, p. 341, text figs. 71 *a-f*, 72 *a-d*.

Corbicula africana can best be described as a small *C. consobrina*, and indeed may well be either the young or undeveloped form of that species. On the upper surface fresh shells generally show two conspicuous light areas, radiating from the umbo, but in the fossils this cannot often be made out. *C. radiata* is, however, an invalid name for the species based on this character, since the name is preoccupied.

When this shell occurs in association with *C. consobrina*, as it frequently does, it is impossible to separate it from young forms of the latter. In many areas, however, mature shells are found in colonies entirely by themselves, and cannot then be regarded merely as young *consobrina*, though they can, and probably ought to, be considered as stunted and undeveloped forms of that species.

In the Faiyum *C. africana* frequently occurs without any larger forms, or with but very few and often obviously derived specimens. In these cases it was found that the deposit was invariably a sand, often a very fine one. In the few instances where a *Corbicula* was found in clays it was also the small type. Conversely, the large *Corbiculæ* were *never* found in any quantity outside of gravels.

Here again it is dangerous to generalise without further evidence from other parts, but so far as the Faiyum fossil forms are concerned the above holds true.

The explanation is not obvious and awaits further investigation.

Family : SPHÆRIIDÆ.

Genus : PISIDIUM C. Pfeiffer 1821.

In determining the species of this difficult genus in the Faiyum lake beds the experts to whom they were submitted were handicapped not only by the

limited knowledge of the past and present *Pisidia* of the whole Mediterranean basin, but also by the state of preservation of the fossil material.

It must, therefore, be clearly understood that the names given to the Faiyum shells are tentative, and subject to revision when more is known of the whole genus in these regions.

With this proviso, there appear to be six species represented in the Faiyum, five of which can be referred to European types of to-day. The sixth is now living near Alexandria, where a variety of one of the European forms — *P. casertanum* is also still to be found. The others have not so far been recorded from Egypt.

The distribution of species between the two lakes is very uneven — five occurring in the Palaeolithic, and only two in the Neolithic. Of these two, one, *P. nitidum*, is also found in the Palaeolithic, the other is the Alexandrian form mentioned above, which has Indian affinities.

There is a further and very interesting distinction between the *Pisidia* of the two lakes. Those from the Palaeolithic were collected only from the Tamiya Bank, in the same bed as the large and very variable *Lymnæa lagotis* and the *Hydrobia*. These shells, according to Mr. Stelfox, are mainly freaks, hardly a single valve being normal. In his opinion this points to very unfavourable conditions, a striking confirmation of the conclusion reached by the study of the other members of this assemblage. Moreover, the *Pisidia* share the thinness and transparency of shell noted as a general characteristic in this deposit.

The Neolithic forms, on the other hand, are perfect, not a single freak being among them. They are also on the whole larger and more robust than the Tamiya Bank shells, and this is particularly true of the few specimens found at about 10 m. with a typical Neolithic assemblage. One of these 'giants' is figured in plate VIII, figs. 19-20.

All the above facts seem to the author to confirm the hypothesis of the cutting off of the Palaeolithic lake from the Nile connection in its later stages, and the rejuvenation and freshening of the waters on the formation of the Neolithic lake.

Pisidium henslowanum (Sheppard)?

(Plate VIII, figs. 1-4 (× 7 1/5).)

1825. *Tellina henslowanum* Leach. : M. S. Sheppard, *Trans. Linn. Soc.*, XIV, p. 150.
1927. *P. henslowanum* (Shep.) : Favre, *Moll. Bass. de Genève*, p. 287, text fig. 3 *a*, pl. 17, fig. 23, pl. 20, fig. 1.

This is the commonest Pisidium in the Tamiya Bank associated with the large *Lymnæa lagotis*. The Faiyum shell resembles a small and very depauperated form of the species. The usual appendiculæ on the umbones of *henslowanum* are absent, but it is not unusual for *henslowanum* to be inappendiculate on the margin of its distribution or under unfavourable circumstances.

This species has not been found in the Neolithic lake.

Pisidium subtruncatum Malm?

1853-54. *Pisidium subtruncatum* Malm : *Göthebergs K. Vet Vitt. Sam. Handl.*, III, p. 92.
1927. *P. subtruncatum* Malm : Favre, *op. cit.*, p. 288, text fig. 4 *b*, pl. 17, fig. 16, pl. 21, figs. 1-3.

This species is also confined to the Palaeolithic lake beds, and the following remarks refer to the specimens from the Tamiya Bank in the same bed as *P. henslowanum*. It is fairly abundant but not as numerous as the latter. Some of the shells resemble quite typical *subtruncatum*, while others vary so much towards *P. henslowanum*, that, with only fossil material, it is impossible to separate the two species with absolute accuracy.

Pisidium nitidum Jenyns?

(Plate VIII, figs. 5-12 (× 7 1/5).)

1832. *Pisidium nitidum* Jenyns : *Trans. Camb. Phil. Soc.*, IV, p. 304, pl. XX, figs. 7-8.
1927. *P. nitidum* Jen. : Favre, *op. cit.*, p. 292, text fig. 4 *g*, pl. XVII, figs. 19, 24, 25, pl. XXV, figs. 8-9.

This species is found in both the Palaeolithic and Neolithic lakes, and shells from the different deposits will be considered separately.

The Palaeolithic *nitidum* from the Tamiya Bank is a rather robust form

showing typical hinge characters and in some cases the external nepionic grooves. It does not occur in such numbers as *P. henslowanum*.

The Neolithic shells are on the whole larger (figs. 11-12) and better developed than the Tamiya Bank forms. The valves are thicker and less worn.

It is possible that the Faiyum *nitidum* should be regarded as a distinct variety or race, since the cardinals, especially C 3, are longer than in typical *nitidum*, and the striæ of the shell are closer and finer than usual. The latter feature could be due to climate and is worth little, as *nitidum*, even in England, varies from being almost smooth to having the shell strongly striate or almost ribbed.

Of the figured specimens numbers 5-8 are from the Tamyia Bank, and numbers 9-12 from the various deposits of the Neolithic lake in the northern Faiyum.

Pisidium casertanum (Poli)?

(Plate VIII, figs. 13-14 (× 7 1/5).)

1791. *Cardium casertanum* Poli : *Test. utr. Siciliæ*, II, p. 65, pl. XVI, fig. I.
1909. *Pisidium* (*Fossarina*) *casertanum* Poli : Pallary, *op. cit.*, p. 75, pl. IV, fig. 34.
1927. *Pisidium casertanum* Poli : Favre, *op. cit.*, p. 298, text fig. 4 *c*, pl. 17, fig. 12, pl. 21, figs. 6-8, pl. 22, figs. 1-5.

This species is represented in the Palaeolithic lake beds of Tamiya by two young valves only. The smaller (fig. 14) both externally and internally seems fairly typical of the young of a rather weak form. The larger valve could belong to *P. nitidum*.

It has not been found in the Neolithic lake, though Pallary records a variety, *alexandrina*, living at the present day. This he distinguished from the type by its weaker shell, more elongated form, lesser height and greater inflation.

It is, however, impossible to tell from the one small figure whether this variety is the same as the Faiyum shell or not, or indeed, whether it was correctly identified as referable to *casertanum*.

Pisidium obtusale (Lam.)?

1818. *Cyclas obtusalis* Lamarck : *Hist. Anim. Sans. Vert.*, V, p. 559.
1927. *Pisidium obtusale* C. Pf. : Favre, *op. cit.*, p. 302, text fig. 4*e*, pl. 17, fig. 14, pl. 24, figs. 1-9.

Only one valve which might be assigned to this species was found in the Palaeolithic Tamiya Bank deposits.

Externally and in general shape it resembles *P. obtusale*, though the hinge is rather freakish. It may however, be an abnormal form of the shell referred to as *P. henslowanum*.

It is not known from the Neolithic beds.

Pisidium sp.? cf clarckeanum G. and H. Nevill.

(Plate VIII, figs. 15-20 ($\times 7\frac{1}{5}$).)

1871. *Pisidium clarckeanum* G. and H. Nevill : *Journ. As. Soc. Bengal.*, XL, Pt. 2, p. 9, pl. I, fig. 4.
1925. *Pisidium clarckeanum* G. and H. Nevill : Prashad, *Rec. Ind. Mus.*, XXVII, pp. 405-422.

The identification of this species in the Neolithic lake beds is at present only tentative, as more material is required for comparison, but Mr. Stelfox is satisfied that the Faiyum shell is closely related to, if not specifically identical, with the Indian *P. clarckeanum*. Therefore it has seemed better to give it this name, rather than create a new species on inadequate data. Its eastern affinities are of extreme interest, and introduce a fresh element into the later faunas. At the present day it is to be found in the "Canal de Mustapha", near Alexandria, where it was collected by Bourguignat in the middle of the last century. Mr. Stelfox has very kindly compared the Faiyum shell with Bourguignat's undescribed specimens in the Geneva Museum, and can vouch for its identity. He further suggests that when our knowledge of the *Pisidia* of the intervening countries has increased, it might prove to be an outlying, rather starved race of *P. clarckeanum*.

In the Faiyum it was found only in the Neolithic beds in the north, at two different levels.

In the higher of these, + 10 m. — though not abundant, the shells are very robust and much larger than any of the other *Pisidia*. (Pl. VIII, figs. 19-20). Of this specimen Mr. Stelfox writes that it differs from the type of *clarckeanum* in its greatly thickened shell, rather more centrally placed umbones and stronger striation. The ligament pit is extraordinarily narrow — more so than in the Indian form — and is possibly not quite normal. It differs from the smaller, lower-level shells only in extreme size, thickness of shell and coarser striation, but in all species of Pisidium subject to much variation, thick large shells so differ from thin starved specimens.

The other locality in the N. Faiyum is only 2 metres above sea level, and here the *Pisidia* (pl. VIII, figs. 15-18) occur abundantly below the edge of an enclosed basin ('L'), together with *Cleopatra bulimoides* var. *richardi*. It is of great interest that shells now so widely separated in their habitats should have affinities in the Faiyum Neolithic, and seems to bear out the other evidences of migration at this time (see p. 80).

The characters of this low-level *Pisidium* are as follows; "Ligament pit very long, straight and narrow, anterior lateral teeth long with graceful sweeping curves, their apices being almost distally situated; hinge plate very narrow; outline of shell obliquely oval, with the umbones much nearer the posterior end; striation close and regular. Size $3.0 \times 2.3 \times 2.0$ mm.".

The texture of the shells is thin, and resembles that of the Tamiya Bank *Pisidia*, but unlike the latter there is not a single freak among them, every valve being perfect.

Considering the Faiyum *Pisidia* as a whole, it appears that there are shells of three different developments. (1) the large, thick, robust specimens; (2) the smaller, thin, but perfect shells; and (3) smaller, thin and freakish forms. Though belonging to different lakes (1 and 2 Neolithic, and 3 Palaeolithic) it is significant that this is also the order of decreasing level — namely + 10 m., + 2 m. and — 1 m., and it seems hard, therefore to avoid the conclusion that these differences in development are directly correlated with the degree of concentration of the water, and possibly to a lesser extent with difference of habitat or temperature.

The Neolithic lake at 10 m. was characterised by the abundance and variety of its fauna (see p. 80), but as it fell the open sheet of water in the

north would have been confined to the isolated basins — such as 'L' — where, obviously, conditions would not have been so favourable for growth.

No *Pisidia* have so far been found in the lower Neolithic levels, but the abnormalities of other genera associated with the freakish *Pisidia* in the Tamiya Bank (p. 99) seems to point to extremely unfavourable conditions, probably consequent on the actual drying up of the pool in which these animals were living (p. 100).

Stage 2 would then represent an intermediate state, between the free, fresh, open, though probably shallow-water forms at + 10 m., and the restricted and probably saline-water shells of stage 3.

Genus : **SPHÆRIUM** Scopoli 1777.

Sphærium pharaonum Bourguignat.

(Plate VIII, fig. 21 (× $7\frac{1}{5}$).)

1909. *Sphærium pharaonum* Bgt. : Pallary, *op. cit.*, p. 74, pl. IV, fig. 26.

This small bivalve is not common, but has been found in the Neolithic lake beds near Dimê, and to the south west of 'L' Basin. In all cases in a sandy deposit.

Only a few specimens were found at each locality and these show no special features.

Family : SCROBICULARIIDÆ.

Genus : **SCROBICULARIA** Schumacher 1816.

Scrobicularia cottardi Payraudeau.

(Plate VII, figs. 55-59.)

1826. *Lutraria cottardii* Payr. : *Cat. descr. et méthod. des Annélides et Moll. de l'Ile Corse*, p. 28, pl. I, figs. 1, 2.
1927. *Scrobicularia cottardi* Payr. : Gardner, *Geol. Mag.*, p. 400, text fig. 6.

This shell has been discussed in the author's previous paper and little need be added here. Though quite common, it never occurs in such quantities

as the *Cardium*, and was found in place in the sandy mud close to present water level.

Like the *Cardium* it is unknown from the old lake beds.

Family : CARDIIDÆ.

Genus : **CARDIUM** Linnæus 1758.

Cardium edule Linnæus var.

(Plate VII, figs. 60-70.)

1878. *Cardium edule* Linn. vars. : Tournouer, *Ass. Française pour l'avancement des Sciences*, VII, pp. 608-622, pl. VI.
1927. *Cardium edule* var. *clodiensis* Rve. : Gardner, *op. cit*, p. 400, text fig. 5.
1929. *Cardium edule* Linn. *sensu lata* : Gambetta, *Ann. Mus. Genova*, vol. LIII, pp. 277-293.

The occurrence of a marine shell in the present lake has been discussed elsewhere (Gardner, *op. cit.*, p. 400). Its main interest lies in the fairly close limits to which its introduction can be dated, and its amazing abundance after such a relatively short time.

In 1908, when Dr. Cunnington's expedition made a zoological survey of the lake, there was no sign of it, neither has it been found in any of the old lake beds.

This fact might seem to be against the theory that the Palaeolithic lake partially or completely dried up. On the other hand the present lake has been brackish for some time, yet it is only within the last twenty years that two marine or estuarine species have flourished, although the brackish water *Hydrobia peraudieri* was long ago recorded from it. Therefore it is quite possible that the Palaeolithic lake became brackish, yet did not chance to have the *Cardium* and *Scrobicularia* introduced into it.

The shells discussed previously were all small specimens picked up on the north shore of the Birket Qarun. They are figured on pl. VII, figs. 60-62. In 1927 the south shore was visited and there the large forms were collected (figs. 66-68). They occur in thick shell banks, whitening the beach as they are driven in by the on-shore wind. Search was made for a shell

containing the animal and eventually two or three were discovered by Miss Caton Thompson clinging to pieces of algae.

The most striking feature about these southern shells, apart from their larger size, is their greater length when compared with the northern specimens.

By the kindness of Professor Stanley Gardiner the author was able to examine Sir William Bateson's collection of Cardiums from the old levels of the Sea of Aral and elsewhere. Some of these are very similar to the Faiyum forms, having the same elongated shape and the pronounced ribbing inside the shell. The nearest were naturally those collected from the adjacent Mediterranean coast (pl. VII, figs. 63-65).

To Mr. Tomlin the author is indebted not only for the identification of the species, but also for the interesting information that Cardiums of similar form occur in isolated pools along the Sussex coast, growing among seaweed, not buried in the mud in the usual habit (figs. 69-70).

In digging close to the water level in the Faiyum, *Scrobicularia* were found in the position of growth, but no Cardiums, and this together with the occurrence of live specimens attached to weed suggests that the similarity of shape is attributable to similar habitats.

FAUNAL ASSEMBLAGES.

The characteristic faunal assemblages for the Pleistocene and Neolithic lakes were given in the writer's *Geological Magazine* paper for September 1927. At that time, however, the 30 m. gravels had only been examined in one area, while the Tamiya and Edwa Banks were not visited at all. Moreover, further collecting has modified the view formerly taken of some species, therefore the whole subject will now be reviewed afresh in the light of new knowledge.

PLEISTOCENE LAKE.

General Characteristics.

One of the most striking features of the Pleistocene assemblages is the very marked difference between those of the north and south shores. Therefore in the general list below it must be remembered that the whole fauna is unlikely to be found at any one place.

There are certain forms, however, which can be regarded as characteristic of this lake, since they do not appear to occur in Neolithic times.

These are :

Bithynia connollyi Gardner.
Lymnæa lagotis Schrank.
Lymnæa mæris Martens.
Planorbis planorbis (Linn.).
Corbicula vara Gardner.
Unio fayumensis Pilsbry and Bequært.
Pisidium casertanum? (Poli).
Pisidium henslowanum? (Sheppard).
Pisidium obtusale? (Lam).
Pisidium subtruncatum? Malm.

Of these, all except the *Planorbis* and *Pisidium casertanum* are not now living in Egypt, while the *Bithynia*, the *Corbicula*, the *Unio* and *L. mœris* are not at present known, either living or fossil, outside the Faiyum. *Planorbis planorbis* appears to be the same as the modern *P. philippii* and *subangulatus*, the former recorded by Pallary from the Nile, and the latter by Blanckenhorn from the Birket Qarun.

Other species occur in both lakes, but are commoner in the Pleistocene than in the Neolithic. These are :

Bithynia neumanni Mts.
Bithynia tilhoi Germ.
Lymnæa cailliaudi Bgt.
Corbicula artini Pallary.

The other shells listed from the Pleistocene are either equally common in both lakes, or more characteristic of the Neolithic.

Lateral Variation.

The variation in the faunal assemblages on the different sides of the basin of the Pleistocene lake is very marked. This distinction is most noticeable in the case of the northern fauna, the east, south, and west being much more similar. In the following list these latter are grouped together for purposes of comparison with the north.

NORTHERN.	SOUTHERN, EASTERN AND WESTERN.
Lanistes carinatus (Oliv.).	*Bithynia connollyi* Gardner.
Lymnæa cailliaudi Bgt.	*B. neumanni* (Martens).
L. natalensis Krs.	*B. tilhoi* Germ.
Pila ovata (Oliv.).	*Hydrobia peraudieri* Bgt.
Planorbis mareoticus (Let.) Innes.	*Lymnæa lagotis* Schrk.
Corbicula consobrina (Caill.).	*Lymnæa mœris* Mts.
	Planorbis planorbis (Linn.).
	Corbicula artini Palry.
	Corbicula vara Gardner.

Most of the species in these lists are not absolutely confined to their different regions, with the exception of *L. mœris* and *Corbicula vara*, which so far

have never been found in the north. *Corbicula artini* occurs with *consobrina* in the northern gravels, but is not the dominant form, while *L. lagotis* and *Planorbis planorbis* are only very sparingly represented.

In attempting an explanation of the above facts two possibilities must be considered :

Is the difference due to level or is it due to different physical conditions, and if so, what are they?

With regard to the first question, so far as can be made out, the distinction holds good for all levels. The lower levels of the Pleistocene lake are not easily studied in the north, since they are obscured by later deposits.

On the other sides they can be observed in some of the low lying banks. It is, however, certain that the faunal assemblages of the 30 m. gravels in the north and south are markedly different in composition, and the lower deposits of the Tamiya Bank show no admixture of the northern types.

For these reasons the distinction cannot be attributed either to variation in depth with a constant water level, or to the comparison of one stage in the falling lake in one region, with a different stage in the other.

In considering the question of physical conditions reference to the characteristic habitat of the living animals is of great use. In this connection the most striking fact is that the northern assemblage is, except for the *Corbicula*, predominantly composed of still-water loving forms. This is especially true of *Lanistes* and *Pila* which live now on the marshy edges of rivers or in stagnant pools and arms of lakes.

In the southern region *Pila* has so far never been found, while *Lanistes* is very rare.

The absence of these and other common Nilotic forms from the Edwa Bank led Blanckenhorn to suppose that at the time of its formation connection with the White Nile had not been established. This conclusion would, however, seem to have been based on insufficient evidence and without due regard to the physical conditions under which the bank was formed.

To the writer the true explanation of this, and the other variations in the assemblages, is to be found in the topography of the basin and widely different physical conditions on the north and south side of the lake to which it gave rise.

In the introduction the steep and high northern rim of the basin was noted. Immediately below this lies a fairly broad plateau with an average elevation of about 11 m. sloping gently north. The surface of this plateau is broken by an east-west series of isolated basins sinking to below sea level. The basins were in existence *before* the formation of the Pleistocene lake, and it is obvious that these features taken in conjunction with the high protecting cliffs behind would give rise to just such conditions as those mentioned above, in which still-water forms would flourish. This is emphasised by the fact that the dominant winds of those time were westerly and north westerly, as Messrs. Sandford and Arkell have shown on the evidence of the great storm beaches piled up along the east side of the basin.

This being so, as soon as the shelter of the northern cliffs was left, very different physical conditions would obtain along the shores of the Pleistocene lake. The force developed by waves travelling across a sheet of water some 30 km. wide and 40 m. deep would have been considerable, and its effects should be seen in the fauna, especially that of the highest levels when the reach of the waves would have been greatest.

In this connection the character and distribution of *Corbicula vara* seem to be particularly significant. The extreme thickening of the shell, especially in the umbonal region, its great height compared to the length, and the marked inflation of the valves could all be explained as a response to the force of the waves in which it lived. Further, its apparent restriction to the exposed shores seems to point in the same direction. A third line of evidence is to be found in the fact that *C. vara* is particularly characteristic and abundant at the higher levels of the Pleistocene lake; it is found in numbers in the 30 m. gravels, but except for a few specimens at about 20 m. in the Edwa Bank it has not been found at the lower levels. This fits in excellently with what we should expect from the relation of waves to area mentioned above.

If *C. vara* is really confined to the Faiyum and does not occur in deposits of the same age in the Nile Valley, the case for its local evolution as an adaptation to wave action will be considerably strengthened.

Further evidence for the effect of wave action is the greater thickness of shells on the south west shore, compared with the north side. This is particularly noticeable in the case of the Lymnæas. *L. lagotis* in the shell

bank on the western side is markedly thicker than either the Tamiya Bank or northern forms.

The absence of such species as *Lanistes carinatus* and *Pila ovata* and the development of such a form as *C. vara* finds a reasonable explanation in the difference of exposure on the north and south shores. It does not, however, entirely account for the other characteristic southern types, except in so far as palæontological, as well as modern evidence, goes to show that where there is a critical change in conditions, there variation and production of new forms is to be expected. Now the southern margin of the Faiyum basin would more particularly answer to this description, for not only was wave action dominant, but the inlet channel from the Nile Valley opened out in this region. This might have affected the lake faunas in two ways. First of all it provided the one and only means by which fresh water shells could voluntarily migrate into the basin, and secondly, the régime of annual high and low water, which seems even then to have been in existence, must have profoundly affected the physical conditions, and with them the fauna of the area nearest the inlet channel.

With regard to the first point, it is not without significance that the forms most characteristic of the southern regions are either almost entirely local or widespread types, which, with the exception of *Planorbis planorbis,* are not now living in Egypt. *Bithynia neumanni* and *B. tilhoi* are both Central and West African forms, while *Lymnæa lagotis* and *Planorbis planorbis* are typical Palæarctic species.

It is, therefore, tentatively suggested that the connection with the Nile, together with the wider extension of pluvial conditions in the Pleistocene, allowed of the migration of these extra-Egyptian types into the Faiyum by way of the Hawara Channel. Why, then, did they not spread in any quantities to the north of the basin? The answer to this seems to the writer possibly to be found in the most suggestive remark of Geyer (1929, *op. cit.*, p. 205), that, for purposes of distribution, waves are to the aquatic mollusca what wind is to plants. So far as is known, currents were not much in evidence in the Pleistocene lake, and therefore waves would have been almost the sole means by which the eggs and young of the newly arrived and evolved forms could be carried to other parts.

Now, it has already been shown that wave action was all towards the southern and eastern shores and migration northward would, therefore, have been a severe struggle against the prevailing forces. This would satisfactorily account for the fewness, in both species and numbers, of the southern types that reached the north.

The proximity to the inlet channel might have influenced the fauna most when the lake was falling, and shoals and sandbanks began to choke the entrance. This would lead to the cutting off of isolated pools between the sandbanks and the possibility of development in them of species not found elsewhere. They would moreover be liable to flooding and removal at times of extra high water, since the Nile connection would only gradually have been cut off and would have been periodically renewed at especially high floods.

It is thought possible that the presence of *Hydrobia peraudieri* in the Edwa Bank may perhaps be accounted for in this way. It it provisionally suggested that the water may locally have become isolated and somewhat brackish in the manner indicated above, thus allowing this particular type to gain a temporary foothold. It is never found in any numbers in the Edwa Bank and is there confined to one bed only.

Apart from these sporadic occurrences of *Hydrobia* there is no indication that the Pleistocene lake above sea level was brackish. The well marked pauses in the fall probably indicate periods of rather greater rainfall, which not only counterbalanced evaporation and maintained a fairly constant water level, but at the same time kept the lake fresh.

According to the writer, as the lake fell the connection with the Nile, which was practically cut off by the bank and shoals at the Hawara entrance to the Basin, was *not* re-established, and eventually the depression became dry or nearly so.

This view has lately been challenged by Messrs. Sandford and Arkell, who maintain that in the later stages of the Palaeolithic a river system developed in the Faiyum, causing a flow of water into the Nile, and deepening the Hawara Channel and the Faiyum itself *pari passu* with the erosion of the Nile Valley.

Now, the low levels to the north of the Birket Qarun are very largely hidden by thick drifts of sand, while to the south there is a 'blanket' of modern alluvium and cultivation which hinders observation. It is, therefore, very difficult to get direct evidence bearing on these divergent opinions, but the deposits of the Tamiya Bank, whose base is at 5 or 6 m. below sea level, have some bearing on the problem. This will, however, be considered at the end of this section, since in the writer's view, both the Tamiya and the Edwa Bank are of composite origin, formed mainly by the Pleistocene but modified by the Neolithic lake. Suffice it to say here that as the molluscan assemblage of the Pleistocene part is concerned, the most notable feature in the Tamiya Bank is the great abundance of individuals of *few* species only and the coming in of *Hydrobia* in great numbers towards the top of the Pleistocene deposits.

These facts seem to the writer to be more in accord with a falling lake than with a developing river system.

Summary.

The most important and interesting features of the faunal assemblages of the Pleistocene lake can then be summarised as follows :

(1) While the majority of species are typically African, there is a certain admixture of Palæarctic forms, such as *Planorbis planorbis, Lymnæa lagotis* and the *Pisidia.*

(2) Indirect connection with tropical West Africa and the Lake Chad Basin seems to be indicated by the presence of *Bithynia tilhoi, B. neumanni,* and *Mutela dubia* not living in Egypt at the present day.

(3) It is distinguished from later lakes by the development of peculiar characteristics species, not at present known either fossil or living outside of the Faiyum Basin. These are *Bithynia connollyi, Lymnæa mœris, Corbicula vara* and *Unio fayumensis.*

(4) It shows a very marked difference in the faunal assemblages from the north compared with other parts of the Basin. This is to be attributed to the influence of the different physical conditions, mainly the degree of exposure and wave action.

(5) The waters appear for the most part to have been fresh, but the presence of *Hydrobia* in small numbers in the Edwa Bank and in large numbers at Tamiya probably indicate brackish conditions locally.

NEOLITHIC LAKE.

The characteristic species of the Neolithic lake are as follows :

Bithynia goryi Bgt.
B. senaariensis (Itüst.).
Cleopatra bulimoides cf. var. *richardi* Germ.
Cleopatra pirothi Jick.
Lymnæa natalensis Krs.
Planorbis alexandrinus Ehrn.
Planorbis mareoticus (Let.) Innes.
Planorbis stanleyi Smith.
Segmentina angusta Jick.
Theodoxus niloticus (Rve.).
Chambardia locardi Bgt.
Corbicula africana (Krs.).
Etheria elliptica Lam.
Mutela dubia (Gmelin).
Pisidium sp. cf. *clarckeanum* G. and H. Nevill.
Unio (*Nodularia*) *teretiusculus* (Phil.).

In analysing the above list the first striking feature, in contrast to the Palaeolithic lake, is that no single species is confined to the Faiyum; and the second that the Palæarctic forms of the Pleistocene have gone.

The species are for the most part common Nile forms, the exceptions being *Planorbis stanleyi* which is not living in Egypt, but is found in Abyssinia, the Central Lake Region and West Africa, and in the White Nile at Fashoda; *Mutela dubia,* a West African and Uganda shell, *Chambardia locardi,* only known as a fossil from the old deposits of the Nile at Rameses, north-east of Cairo, and *Cleopatra bulimoides* cf. var. *richardi.* The latter is found in Lake Chad, but until other occurrences are known it would be unsafe on this evidence alone to assume a connection with that region. It may be a local Faiyum development showing convergence.

Of the other species given in the table at the end as occurring in the lake, but not particularly characteristic of it, the presence of *B. neumanni* and *B. tilhoi* should be noted, but they are rarer than in Palaeolithic times.

Especially striking is the apparent complete disappearance of the characteristic Pleistocene forms such as *B. connollyi, L. mœris, U. fayumensis* and *C. vara.* In the case of the *Corbicula* and the *Unio* this is not so surprising as they have not yet been found in the low levels of the Palaeolithic lake, but *B. connollyi* occurs in great numbers in the Tamiya Bank and *L. mœris* is also represented there.

These very marked differences between the faunas of the two lakes seem to the writer to be all in favour of the isolation of the Palaeolithic lake as the Nile eroded its bed, and for the lapse of a considerable period of time between the two lakes. Messrs. Sandford and Arkell would only allow a very short interval, but in this case it is difficult to see why some of the characteristic Palaeolithic species did not live on into the Neolithic, especially as, according to the above gentlemen, the Faiyum at that time was not dry, but occupied by a flourishing river system. The occurrence in both lakes of *Bithynia tilhoi* and *B. neumanni,* and other species not now living in Egypt (see p. 107), would seem to indicate that the Pleistocene lake did not altogether dry up, unless these species should be found in the later deposits of the Nile Valley, in which case they might have re-entered with the rest of the characteristic Nile forms.

The differences in the assemblages on the north and south side of the basin, so characteristic of the Palaeolithic, do not seem to hold good for the Neolithic. This conclusion is tentative, since the later deposits south of the Birket Qarun are almost all hidden by cultivation. They are, however, to be found on the north side of the Edwa Bank, where they have the same faunal assemblage as in the north of the lake. The evidence, therefore, as far as it goes, bears out the general considerations in regard to the relation of fauna to wave action discussed above. The Neolithic lake was considerably smaller and, therefore, the waves had less reach; also desert conditions were setting in, and the storm tracks producing the strong westerly and north-westerly winds would lie north of the Faiyum and storms in the area would, therefore, be less frequent and less violent.

A distinction can, however, be drawn in both lakes between the shells characteristic of the clays and loams on the one hand, and sands and gravel on the other, which is to be correlated with preference of the particular animals for muddy or clear water.

Speaking generally, the bivalves are more characteristic of the cleaner sands and gravels together with *Theodoxus* and *Cleopatra pirothi*, while in the muddy waters *Bulinus truncatus* and *Valvata nilotica* occur in great numbers in company with the Planorbids, Lymnæas, and Pilas, while the latter and *Lanistes* are particularly characteristic of the loams.

Among the bivalves, *Etheria elliptica* is confined to rocky places, while the large *Corbiculæ*, such as *consobrina* and *artini* are especially associated with gravel. It was noted very constantly that *C. africana* occurred almost entirely in fine sands, and the few *Corbiculæ* in argillaceous deposits were always this form and not the larger ones. On the other hand, the large *Corbiculæ* were hardly ever found in the finer deposits. This does not seem to be a question of depth, and it is difficult to find a reason for it.

The above description is concerned with the higher levels of the Neolithic lake. When it fell below sea-level a very striking change is to be noted in the composition of the faunal assemblage. The low lying deposits can be well studied in the sheltered areas below the northern plateau, notably along the west side of Mœris Bay and west of Dimê. Here a series of beaches is preserved, with an especially well-developed one at −2 m. Shells are abundant in these deposits together with reeds and fish bones.

The first feature to be noted in the molluscan assemblage is the great falling off of variety. The shells, though numerous individually, are of relatively few genera as compared with the higher levels. The commonest species are :

Theodoxus niloticus (Rve.).
Valvata nilotica Jick.
Cleopatra bulimoides (Oliv.).
Bulinus truncatus (Fér.) Aud.
Planorbis ehrenbergi Beck.
Hydrobia peraudieri Bgt.
Melanoides tuberculata (Müll.).

Planorbis mareoticus, *Cleopatra pirothi*, *Corbicula africana* also occur and *Lymnæa cailliaudi* was collected from a low lying beach.

The genera most conspicuous by their absence are *Lymnæa*, *Bithynia*, *Lanistes*, and *Pila*, together with all the bivalves except *Corbicula africana*.

A further characteristic of this assemblage is the small size of many shells compared with that of the same species at higher levels. This is particularly noticeable in *Theodoxus*, but is not of universal occurrence at the low levels, for this or the other species, and may be due to the conditions of accumulation.

Finally, the presence of *Hydrobia* at levels below −11 m. together with the characters noted above lead to the conclusion that the peculiarities of this faunal assemblage are due to the coming in of brackish water conditions on the fall of the Neolithic lake as the desert climate became more and more pronounced.

The absence of *Lanistes* and *Pila* cannot be put down altogether to dislike of brackish water since they are recorded at the present day from similar conditions in L. Mariout, near Alexandria. It is possible, however, that in the very enclosed and sheltered Mœris Bay, concentration was too great for gradual adaptation to changing conditions.

Summary of Neolithic Lake.

The characteristic features of the faunal assemblages of the Neolithic Lake may be summarised as follows :

(1) Predominance of African types with the disappearance of the Palæarctic species, except *Pisidium nitidum*.

(2) Disappearance of all the local species characteristic of the Palaeolithic lake.

(3) Two species only of the Neolithic assemblage are distinctive, being found neither in Egypt at the present day, nor in the Palaeolithic lake. These are *Chambardia locardi*, a fossil form from the eastern Delta, and *Cleopatra bulimoides* cf. var. *richardi* a West African shell.

(4) The variation of assemblages according to the nature of the deposit is particularly well illustrated in the Neolithic lake. Arenaceous beds are characterised by *Cleopatra pirothi*, *Theodoxus niloticus* and the bivalves, while the argillaceous types have *Bulinus*, *Planorbis*, and *Valvata* as the predominant genera.

(5) The distinction between the northern and southern faunal assemblages of the Palaeolithic lake does not hold good for the Neolithic.

(6) The lower levels of the Neolithic are marked by the coming in of the brackish water *Hydrobia peraudieri*, together with the great falling off in number of species and some tendency for diminution of size of individuals.

THE MODERN LAKE — BIRKET QARUN.

No collecting was actually done in the lake, but shells were picked up along the shore, and from the flats along the margin, which, geologically speaking, are modern and have certainly only been uncovered in the last 200 years or less.

The most interesting and striking feature of the modern lake is the natural introduction into it of true marine or estuarine types, such as *Cardium edule* var. and *Scrobicularia cottardi*. These were found by the writer in 1925 on the north shore, and an account of them given in the *Geol. Mag.*, Sept. 1927, p. 400.

For the sake of completeness it need only be noted here that Dr. Cunnington's expedition to the lake in 1907 found no trace of either the *Cardium* or the *Scrobicularia*, therefore the actual time of introduction can be tied down to the last 20 years. There seems no other explanation possible than that the eggs or young shells were carried in the mud sticking to the feet of birds; but it provides a warning to the geologist against bringing in earth movements or rises of sea level to account for such phenomena as this in the past without other supporting evidence.

Of the species recorded either from the margin or from the lake itself, apart from the two marine forms, the following have not yet been found in the lower levels of the Neolithic :

Lanistes carinatus (Oliv.) and its variety.
Planorbis planorbis Linn.
Viviparus unicolor (Oliv.).
Corbicula consobrina Caill.

With regard to *P. planorbis*, it is recorded by Blanckenhorn from the shore on the north side, without any indication of the state of preservation. It is possible that it was washed in from higher beds. On the other hand, both it and the other types are found in the Nile and under present conditions

migration via the canals and drains to the fresher waters of the Birket Qarun is a simple matter. Moreover, the salinity at the mouths of the drains entering the lake is not as great as elsewhere. These conditions did not obtain in the later Neolithic waters, and this may account for the absence of the above species from its lower levels. It may, however, merely be a question of insufficient collecting.

For the rest, the Birket Qarun assemblage is as meagre as the late Neolithic, and shows the same paucity of bivalves, which are so abundant at higher levels.

In the small depressions, relatively recently abandoned by the shrinking lake, a similar assemblage is found but without either the *Cardium* or the *Scrobicularia*. A feature of these areas is the tendency for *Melanoides tuberculata* to grow much larger than is usual either for the old lake deposits or the average modern ones.

In one such small basin only a few metres in diameter, at the north west end of the lake, a great number of large *Melanoides* were found—the largest being 43.9 mm., while the average for the lake deposits is about 20 mm.

This raises the general question of the relation of the size of a shell to the volume of water in which it lives. Experimental work on Lymnæas (Cooke 1895, p. 94) has shown that the greater the amount of water the larger the shell, and it is therefore sometimes assumed that great size necessarily denotes a great volume of water. Though this has been shown to be true under artificially controlled conditions, it does not necessarily follow in nature, for there innumerable other factors enter, which are not present in the experimental tank. It is not, therefore, surprising to find many exceptions to the above relationship, and in fact the general consensus of opinion among malacologists seems now to be against, rather than for, it. According to Hazay (1881, p. 60) size is limited by favourable conditions, not the amount of water, supporting his statement by the fact that the largest Lymnæas and Planorbids were found in small ponds and swamps only 8–10 m. long. He contends that the spring weather is the great factor in controlling growth and if it is dry slow development occurs producing short and narrow shells.

Favre, in his recent work on the Geneva Basin, also notes that the largest

Lymnæas were found in stagnant water, ponds, etc., not in the big lakes (*op. cit.*, pp. 238-331).

Similarly Miller in 1873 (*Gesch. d. Bodensees*, p. 11) and Geyer (1929, p. 213) found that the shells of Lake Constance were on the whole smaller than the same species in the Swabian lakes of less volume. Further, in Albert and Victoria Nyanza, both lakes of considerable size, *Melanoides* and the Lymnæas are not represented by any large forms.

Pilsbry and Bequært also express doubts as to the relation of large size to great volume, and cite instances of the largest Ampullarias being found in swamps.

It seems, therefore, safer not to take this relationship for granted, and the writer's experience of the Faiyum molluscan fauna goes to bear this out. For each genus, indeed for each species, there would appear to be special conditions under which maximum development can take place. The proverb that "one man's meat is another man's poison" would seem to hold true equally for the molluscan world, and therefore it is perfectly possible to find in any one assemblage some species attaining a great size, having their ideal growing conditions, while others may only be of average dimensions or even stunted. It is therefore necessary to seek this ideal state for the living shell before any deductions can be safely made about the relationship of size and condition either in the present or the past. The geologist would seem to be justified in seeking some general cause, only when *all*, or nearly all, the members of a fauna are affected in the same way, as for instance, general dwarfing, etc.

THE EDWA BANK.

1879. Martens, *op. cit.*, pp. 100-102.
1886. Martens, *op. cit.*, pp. 126-128.
1901. Blanckenhorn, *Zeitsch. Deut. Geol. Ges.*, Bd. LIII, Heft. 3, pp. 444-446.
1921. Blanckenhorn, *Ægypten*, pp. 159-163.

The molluscan fauna of the Edwa Bank is of exceptional interest, since it has been the classical collecting ground for geologists from Schweinfurth onwards, and from it Blanckenhorn made various correlations and deductions with regard to the rest of Egypt.

Stratigraphy.—It is hoped to deal with the complex geological history of the Bank at a later date, but an outline is here given to make the faunal assemblages intelligible.

Speaking generally the outstanding features are as follows :

Overlying the Tertiary at an average level of 14 m. is a bed of dark clay with few or no shells. This is found on both sides of the Bats drain which cuts the Bank about 1 3/4 kilom. west of Seila Station.

The succeeding beds are, however, different on either side of the Bats; those on the east will be described first.

East of Bats.—In the railway cutting, especially on the north side, the overlying series is distinguished by the presence of rounded calcareous grains of various sizes. Some of them are as large as a pea, and may occur in beds 50-100 cm. thick, with very little associated finer material. Others are quite small, and are scattered through sands, or in some cases concentrated in layers by themselves.

This series is important, for it is quite distinctive and occurs *only* on the east side of the Bats, so far as the author's experience goes. It gives, therefore, a sure means of diagnosing the locality from which Schweinfurth's shells were obtained. In his collection in the palæontological section of the University Museum at Berlin, this bed and its associated shells is labelled : "Paludina conglomerat"; Blanckenhorn calls it "Kiesiger Grus von erbsengrossen Geröllchen" (1921, p. 160).

It occurs for some 2 km. south of the Bank, forming the steep and craggy-tops of the cliffs, and can be followed eastward to near the junction of the Bank with the desert on the eastern side of the Basin.

Northwards, however, it dies out very rapidly, since it is not found in the cliff section, a 100 metres or so north west of the line. Further, blocks of the cemented grains, as well as isolated ones, are found in the overlying beds, showing that the calcareous series was being denuded at the time of their formation.

The succeding deposits are coarse gravel and sand, forming the 'Bank' proper. They make a conspicuous feature at the edge of the cultivation on the north side, where the slope is steepest. The highest points are 24 m.

above sea-level, the average being about 22 m. The gravels are often very well sorted and contain numerous pebbles from the Red Sea Hills, showing from their size that the Nile was flowing in with a powerful current. In the sands occasional pockets of small garnets indicate a similar source for the material.

On the north side of the gravel, along its lower slopes there is a sand containing numerous shells characteristic of the Neolithic lake, and as this bed seemed to thin out *on* to the gravel at about 18 m., and not to underlie it, it is considered to be of later origin than the Bank itself, which undoubtedly represents various stages in the fall of the 35 m. Palaeolithic lake. The calcareous series is in all probability related to the earlier stages in the fall, when the material brought in by the Nile was gradually blocking the mouth of the Hawara Channel and building up the plateau on which Medinet-el-Faiyum now stands. The main ridge itself represents the beach deposit of the 22 m. pause, when, for a considerable time, the waves driven across the extensive sheet of water by the prevailing north west—west winds would build up a shingle bank, breaking up, sorting and concentrating the underlying material in the process.

West of the Bats.—On the west side of the Bats the gravel rests directly on the clays, and no trace of the calcareous series was found *in situ*, although small rounded grains derived from it occur sporadically in the gravel. North of the line on this side, there again occurs a fine sand at about 18 m., with numerous shells. On account of human disturbance the relation of this series to the gravel is difficult to make out, but no trace of the shelly bed was found in the cutting and a certain amount of evidence obtained for considering it later than the gravel.

Fauna.—The method of preservation of the shells in the different stratigraphical divisions is distinctive. Those in the calcareous series, as would be expected, are generally thick shelled and opaque; often they are semi-fossilised, and then may form the core of one of the calcareous grains. All sizes of shells were found so preserved, from Bithynias forming little balls, to Corbiculas almost the size of marbles.

In the gravel a few Corbiculas show the same feature, but they are always

very worn, and probably derived from the lower beds. Many *Corbiculæ* are normal, and so are all the *Melanoides*, showing that conditions had changed, and deposition of lime no longer predominated.

In the sand the shells are clean and on the whole well preserved, and of average thickness, no deposition having taken place. The few large *Corbiculæ* among the numerous small *C. africana* are generally much rolled and are probably derived from the lower beds. The same source is to be sought for the few *Lymnæa lagotis* and *Planorbis planorbis*.

The species found in the beds on either side of the Bats, together with Martens' and Blanckenhorn's lists from the same locality are given in the following table; those with an asterisk are particularly abundant (see p. 90, Table I).

In Martens' description it is not stated whether the shells came from the right or left bank of the Bats, but from an examination of Schweinfurth's material in Berlin it is obvious that some at least were from the right, or east side since numerous large calcareous grains are included.

Martens also notes a difference in the mode of preservation; those in loosely consolidated material may well have been from the left bank or from the north slopes of the gravel ridge on the right.

The conclusions drawn by Martens from the fauna were : that it indicated a Nile connection for a long period, and secondly that the mixture of still and running water forms pointed to the various types having been brought together by water from different sources. This would certainly seem probable for the shells of the calcareous series, which are often very worn, especially the bivalves, and sometimes so broken that they form a thin layer of nothing but shell fragments.

The fauna of the sand on the northern side is, however, very much fresher in appearance, the *Corbicula africana* frequently having both valves still united, and the Theodoxids retaining a considerable amount of colour. This fact again lends support to the idea that this fauna is later.

In the gravel ridge itself shells are scarce, rolled *Corbiculæ*, sometimes with an outer casing of calcareous mud, and a few small slender *Melanoides* being the only signs of life. From the nature of the bank this is only to be expected.

Blanckenhorn was the first to draw the distinction between the faunas on

TABLE I. — FAUNA OF THE EDWA BANK.

	EAST.				WEST.	BLANCKENHORN'S COLLECTION.		VON MARTEN'S LIST FROM SCHWEINFURTH'S COLLECTION.
	CALCAREOUS SERIES.		GRAVEL.	SAND.	SAND.	EAST (RIGHT).	WEST (LEFT OF BATS).	
	BASE ONLY.	UPPER.						
Bithynia connollyi	—	×*	—	—	—	B. boissieri. B. new species.		Bithynia (or Hydrobia) Sp.
Bithynia goryi	×	—	—	—	×		B. goryi.	
Bithynia neumanni	—	×	—	—	—			
Bithynia tilhoi	—	×	—	—	—			
Bulinus truncatus	×	—	—	×	×		Isidora contorta.	
Cleopatra bulimoides	—	×	—	×	×	Cleopatra cyclostomoides.	C. cyclostomoides.	
Cleopatra pirothi	—	—	—	×*	×*		C. bulimoides.	
Hydrobia peraudieri	×	—	—	—	—		C. pirothi var. multi-carinata.	C. pirothi var. unicarinata.
Lymnæa lagotis	×	×*	—	×	—	Limnæus palustris.		L. palustris (1 small fragment).
Lymnæa mœris	×	×*	—	—	—			L. mœris.
Lymnæa natalensis	—	×	—	—	—	Limnæus natalensis.		L. natalensis *var.*
Melanoides tuberculata	×	×	×	×	×	Melania tuberculala.	M. tuberculata.	M. tuberculata.
Planorbis alexandrinus	—	—	—	×	—		P. ehrenbergi.	
Planorbis mareoticus	×*	—	—	—	×			
Planorbis planorbis	—	×*	—	—	× (1)	Planorbis marginatus.	P. subangulatus.	P. subangulatus.
Planorbis stanleyi	—	—	—	×	×		Segmentina alexandrinus.	
Theodoxus niloticus	—	—	—	×	×*	Neritina nilotica.		Neritina nilotica.
Valvata nilotica	×	×	—	—	—	Valvata nilotica.	Valvata nilotica.	Valvata nilotica.
Corbicula africana	×	—	—	×*	×			
Corbicula artini	×	×	×	—	×	Corbicula fluminalis.	Corbicula.	
Corbicula consobrina	×	×*	×	—	×			C. fluminalis var. consobrina.
Corbicula vara	—	×	—	—	—			
Unio egyptiacus	—	×*	—	—	—	Unio ægyptiacus.		U. abyssinicus.
Unio fayumensis	×	×*	—	—	—	Unio abyssinicus.		U. schweinfurthi.
Unio cf. niloticus	—	×	—	—	—			

The asterisk indicates that the shell is particularly abundant.

the east and west sides of the Bats; this he attributed to difference of facies. While agreeing with this conclusion to a certain extent, the author would, for the reasons given above, regard difference in age as the primary cause in some cases.

The discrepancies in the various lists now remain to be considered.

Blanckenhorn's differs from Martens' list in the absence of *Lymnæa mœris* and *Unio schweinfurthi*, and the presence of *Bithynia boissieri*, *Cleopatra cyclostomoides* and *Unio ægyptiacus*.

The fundamental distinction in the case of the author's list is the absence of *Lymnæa palustris* and *Unio abyssinicus*. Both these shells are typical of widely separated regions, the first being European and the second confined to Abyssinia.

Unio abyssinicus is one of Martens' own species and is given by him as occurring in the Faiyum. In searching Schweinfurth's collection in Berlin, the author found no trace of the shell, but since the types of *Lymnæa mœris* and *Unio fayumensis* have disappeared that does not necessarily prove it was never there.

In the Unios from the Edwa Bank and surrounding neighbourhood there are none in the author's collection resembling *Unio abyssinicus*, which is typically a much larger, narrower, shell, with a more pointed posterior margin. It resembles *Unio fayumensis* in its thick hinge, strong cardinal tooth, and very deep anterior muscular impressions. There is only one shell that at first sight might be taken for this species; it is figured on pl. V, figs. 12, 13, and was found in a cliff section south west of the Bank. It is certainly rather longer than the typical *fayumensis*, but the ratios show that it must be classed with this form and not with *Unio abyssinicus*.

Martens should have recognised his own species, and therefore the author hesitates to say that *U. abyssinicus* does not occur in the Faiyum. If it is not a question of mistaken identity, it is certainly very rare.

Unio fayumensis was, however, undoubtedly confused by Blanckenhorn with *Unio willcocksi*, also collected by Schweinfurth from an old Nile gravel 30 m. and 8 m. above river level at Gebel Silsile — Upper Egypt. This shell has been described and figured by Newton, and references to it will be found in the systematic section under *U. fayumensis* (p. 51).

Its importance lies in the fact that in Upper Egypt it is associated in the younger Diluvium with prehistoric remains (*op. cit.*, 1921, p. 171), and on this basis Blanckenhorn correlated the Edwa Bank gravel with this stage of the Nile, attributing to both a late date geologically (*op. cit.*, 1901, p. 446).

In the Berlin Museum are the very shells collected by Schweinfurth, two of which are figured on plate V, figs. 17, 18, by the kindness of the Museum authorities. On Schweinfurth's original label '*U. Dembeæ*' has been written possibly by Martens, for Blanckenhorn has relabelled it as follows : '*Unio* (*Dembeæ*) *Schweinfurthi* Mart. = *Willcocksi* Newt.' At a demonstration given to the Geological Society in 1929 the differences between the two shells were pointed out, and these are so obvious from the figures (plate V) that they need not be further laboured.

The presence of *Lymnæa palustris* in both the older lists calls for some remark, since if established it would definitely prove a southward or eastward migration as it occurs in North West Africa. The reasons for regarding this as a case of mistaken identification on the part of Blanckenhorn have already been discussed in the systematic section under *L. mæris* (p. 13). The existence of *Lymnæa palustris* in the Faiyum must therefore be regarded as non-proven.

Bithynia boissieri, a southern European shell, noted by Blanckenhorn must also stand in the same category. A few shells so labelled by Blanckenhorn himself are in the systematic collection, four are figured on plate III, figs. 68-71. Some of them are indistinguishable from specimens also labelled by Blanckenhorn "*Paludinella* (*Hydrobia*) oder besser *Bithynia* n. sp. Schlanke *B. Boissieri*". It seems evident here that he has simply called these shells *B. boissieri* on the grounds that Martens' compared them to a slender variety of that form. Martens himself, however, and all other malacological authorities to whom they have been shown, agree in regarding the species as new.

Cleopatra cyclostomoides is according to Pallary's figure (*op. cit.*, 1909, pl. IV, fig. 17) a thinner form than *C. bulimoides,* but there is so much variation in the latter that a distinct name has not here been used.

Lymnæa lagotis (pl. I, figs. 53-63) is in the author's list, but not in the other two. In the calcareous series a considerable variety is found in the Lymnæas; some are certainly typical *natalensis,* but these are in the minority.

Others are good *lagotis,* but there are a fair number which do not fit into either category. The spire is shorter than the typical *lagotis,* but the mouth more resembles that form than *natalensis.* It is probable that this is the shell called by Martens *Limnæa natalensis* var. On the whole, however, *lagotis* is here the dominant form, as elsewhere in the south of the basin.

The interest of the Edwa Bank fauna lies, then, not so much in the presence of widely travelled forms, but in the existence of types peculiar to the Faiyum, such as *Unio fayumensis, Lymnæa mæris,* and *Bithynia connollyi.* It is significant that all three are characteristic of a series marked by peculiar lithological conditions. *Unio fayumensis* seems to be almost confined to the series, while *Lymnæa mæris* is far commoner in it than elsewhere. *Bithynia connollyi* is the only one of the three that has a wider range both laterally and vertically.

Some explanation of these facts is attempted in the description of the Palaeolithic faunas as a whole (p. 77).

In the table of the entire fauna it will be noted that various species are marked as occurring in the Edwa Bank which are not dealt with above.

This is because they were not found in the type localities described, and in some cases occurred a little distance from the Bank proper.

The first of these is *Viviparus unicolor,* which was found along with *Cleopatra pirothi, Planorbis mareoticus, Melania tuberculata,* and *Theodoxus niloticus* in sand definitely underlying the coarse gravel about a kilometre west of the Bats. An artificial cutting has been made here, and the beds exposed in a small ledge. This is the fauna that lends support to Blanckenhorn's view that the difference between the assemblages of the right and left banks is due to facies. Here it must be older than the shingle bank above, but how much older and what its relation is to the calcareous series was impossible to determine. Shells were abundant in the deposit, *Corbicula africana* being very common and often having both valves united. *Cleopatra pirothi* was fairly numerous, some specimens being very fresh and others worn. *Theodoxus niloticus* was also abundant but the shells were all very much more worn than those in the sand north of the bank by the Bats.

Search was made for this bed on the south of the Bank at about the same level + 19 m., but either it had there become unfossiliferous, or else it had died out altogether, for no trace of it was found.

The very large forms of *Viviparus unicolor* mentioned on page 27, and figured pl. II, fig. 63, were found in a peculiar coarse deposit near the drain level south west of the line. They are associated with large *Cleopatra bulimoides*, large *Planorbis alexandrinus*, *Valvata nilotica*, *Bulinus truncatus* of the usual size, one or two very large *Corbicula consobrina*, *C. africana*, and a fragment of *Etheria elliptica*.

This assemblage was at first a great puzzle, till a fragment of heavy Ptolemaic pottery was found well embedded in the deposit. It was then realised that from its position across the mouth of a small lateral wadi it probably represented a Ptolemaic irrigation embankment, or rather the relics of a destroyed one.

The second shell not found in the type locality is *Aspatharia hartmanni*. It occurs with *Cleopatra bulimoides*, *Lymnæa natalensis*, *Bulinus truncatus*, *Corbicula consobrina* and *C. artini* in a grey clay with sandy partings, small garnets being conspicuous in some layers. The deposit was found below the projecting cliff made of the calcareous series, which forms the steep southern side of a narrow wadi, joining the Bats about a kilometre south-east of the railway crossing. Though lower than the calcareous series it seems to be later, for the bed is not traceable *in* the series, but is laid along its flanks, as though deposited at a high level stage in the erosion of the wadi. The assemblage, as far as it goes, and the level, suggests a Neolithic date for this event.

Finally, the only other outstanding fossiliferous deposit that needs mention is that in which *Unio niloticus* and *U. egyptiacus* figured on pl. IV (figs. 2, 3, 15–17, 19) were found. This is a clay which stands up as a bare mound surrounded by cultivation on the south of the line near Seila Station. The shells are all very white and fresh looking, and some of them, notably *Bulinus truncatus* are very large. The other species found here were :

Bithynia senaariensis.
Cleopatra bulimoides.
Cleopatra pirothi.
Lymnæa natalensis.
Melanoides tuberculata.
Viviparus unicolor.
Corbicula consobrina.
Unio fayumensis.

The notable feature is the presence of *Unio fayumensis*, which was however represented by a single specimen only. Moreover, instead of being fresh and unworn as are the other Unios, it is broken, somewhat rolled, and lacks the shining surface of the others. It is therefore probably derived, but the age and significance of this isolated deposit must be left until further work can be done on the area.

West of Edwa the upper layers of the Bank have been much disturbed by human occupation, bits of pottery being found in the top metre. It was in this area that the one and only representative of a shell, partially terrestial in habit — the *Succinea* — occurred. Only one specimen was found.

THE TAMIYA BANK.

The Tamiya gravel bank is an isolated stretch of desert lying in the cultivated area in the north-east of the province between the villages of Tamiya and Kafr-Mahfuz. Its E. N. E. to W. S. W. axis is some 5 kilom. long, the average breadth being about 1 kilom. The lower limit against the cultivation is bounded by contours — 5 m. and — 6 m. below sea level, while the two highest areas, at the north-east and south-west ends respectively, are + 6.6 and + 5.2 m.

The top of the ridge is comparatively narrow, and about a kilometre from the Tamiya end it bifurcates, one branch running slightly west-south-west, and the other almost due south.

About half way down the bank there is a very distinct change of slope, a well marked terrace shown by the closing in of the contours occurring at about sea-level.

The best sections are to be seen at the north-east end on the north-west side, where a cliff has been formed just below the change of slope by diggers of 'sabbakh'.

The detailed succession and variations shown in this section are not the concern of this paper, but in order to make the relation of the faunal assemblages clear, a short description of them is necessary.

1. The basal bed exposed in the diggings is fine yellow sand, with a streaky appearance due to the occurrence of shells concentrated along certain lines.

2. Above this comes 1-1 1/2 m. of grey sand and gravel very current bedded, the direction changing rapidly, but being predominantly west-south-west. The layers are well sorted according to gravity, the coarse ones containing quite large angular masses of fresh water limestone. Certain layers, particularly towards the base, are practically entirely made up of shells, many of them partially or entirely fossilised; they are the same kind as those in the freshwater limestone fragments. Rounded quartz pebbles are frequent, and flint or chert is subordinate.

All the above facts go to show that the beds were laid down subject to strong current action. The water apparently came from the east-north-east and was evidently breaking up some recently consolidated fresh water bed at no great distance from the present bank.

3. The most interesting bed faunistically is that overlying the gravel. It is a thin layer of fine marly sand only 20-23 cm. thick, which lies horizontally on the beds below and does not share in their current bedding.

It is traceable for some 100 metres. At the south end it is unfossiliferous, and disappears below the talus of the cliff. Towards the north, however, it soon contains numerous pockets of shells, large *Lymnæa lagotis* being the commonest form.

Further north still, shells become less numerous and finally die out. The cliff is here much obscured by talus, but in a section towards the north end a layer of similar composition and thickness to the fossiliferous band underlies the top gravel, and overlies a coarse, dirty yellow sandy layer, having all the appearance of wadi wash. The marly sand here shows small ripple-like undulations and eventually wedges out at the junction of a bifurcation in the wash. The grey gravel series below is reduced to 30 cm. and eventually disappears altogether, the wadi wash lying directly, with a very irregular junction, on the streaky sand, sometimes penetrating it in narrow pipes 60 cm. long.

It will be seen, then, that the Lymnæas occur in a very restricted area, and this taken in conjunction with the peculiarities of the fauna is significant.

4. Overlying this "*Lymnæa* Band" is a thick gravel bed forming the top of the bank. It is distinguished at once from the lower gravel by its darker

colour, and by the presence of rounded pebbles of flint and chert in much greater quantities. Angular fresh water limestone fragments are not found, while the faunal assemblage is more varied and distinct from the lower beds, except where pockets of the latter have been caught up near the base of the upper gravel.

The fauna of these different divisions is shown in the following Table ;

TABLE II. — FAUNA OF THE TAMIYA BANK.

	1 FINE YELLOW SAND.	2 GREY GRAVEL.	3 FINE MARLY SAND.	4 FLINT GRAVEL.
Bithynia connollyi	×*	×*	×*	×
Bithynia goryi	×	—	×	—
Bithynia neumanni	×	×	×	—
Bithynia tilhoi	×	×	×	—
Bulinus truncatus	—	—	×	×
Cleopatra bulimoides	—	—	×	×
Hydrobia peraudieri	—	—	×*	—
Lymnæa lagotis	×	×*	×*	—
Lymnæa mœris	—	×	×	—
Lymnæa natalensis	—	—	—	×
Melanoides tuberculata	—	—	—	×
Planorbis alexandrinus	—	—	—	×
Planorbis mareoticus	—	—	×	×
Planorbis planorbis	—	×*	×	—
Segmentina angusta	—	—	—	×
Theodoxus niloticus	—	—	—	×
Valvata nilotica	×*	×*	×*	×
Corbicula africana	—	—	×	—
Corbicula artini	—	×	—	—
Corbicula consobrina	—	×	—	×
Pisidium casertanum?	—	×	×	—
Pisidium henslowanum?	—	×	×*	—
Pisidium nitidum?	—	×	×	—
Pisidium obtusale?	—	×	×	—
Pisidium subtruncatum?	—	×	×	—
	6	14	18	11

The asterisk indicates that the shell is particularly abundant.

From this it will be seen that the series falls into two definite faunal divisions, the line of separation occurring above the marly sand. The distinction is greater than appears on paper, since of the species common to the two, *Bulinus truncatus* and *Cleopatra bulimoides* are only very sparingly represented in the lower beds, and the same is true of *B. connollyi* in the upper gravels.

Moreover, in the latter this shell is partially fossilised and is, therefore, in all probability derived, since fossilization does not occur among any of the other shells of this series.

The rest of this assemblage is marked off by the occurrence of *Lymnæa natalensis* in place of *L. lagotis*, and the presence of *Planorbis alexandrinus*, *Segmentina angusta* and *Theodoxus niloticus*, all forms occurring in both the Palaeolithic and Neolithic lakes, but with a preference for the Neolithic one.

The lower series is distinguished by the singular absence or rarity of shells that are common in other parts. *Melanoides tuberculata* is almost universally found elsewhere, but is absent here, while of the total 51 species known altogether from both lakes, only 16 are found in this assemblage. On the other hand the number of individuals of the few species represented is very great, entire beds being formed of nothing but shells in certain places. By far the most characteristic genus is *Bithynia*, and of the various species *B. connollyi* predominates.

This fact, together with the occurrence of *Lymnæa lagotis* and *L. mœris* definitely links this older series with the Palaeolithic lake.

The question then arises as to whether the beds represent a stage in the rise or the fall of this lake. Two lines of reasoning point to the conclusion that the fall of the lake is involved. The first is indirect, and is concerned with the character of the assemblages. Had they been living in a rising lake, connected with a fresh flow of Nile water, the variety of type should have been much greater. It has been seen above (p. 80) that the Neolithic lake under similar circumstances received a number of Nile forms, among which bivalves were particularly abundant. In the Tamiya Bank, bivalves are rare, a few *Corbiculæ* and *Pisidia* being the sole representatives of the class, the Unios are all, apparently, absent.

The second line of reasoning is based on direct evidence from shells found at other places. On the banks of a small canal 8 kilom. north-east of Tamiya on the edge of the cultivation at 15 m. an interesting succession was found which contained shells preserved in exactly the same way as those in the lower series. Moreover, the types were identical with those found in the grey gravel (Bed 2 of the Tamiya Bank). This fact taken in conjunction with the current bedding and angular fragments of fresh water limestone of the grey gravel, leads to the conclusion that it was derived from the higher bed to the north-east at that time being denuded, and deposited in the Tamiya Bank. The agent was in all probability the water of an intermittent wadi, flowing into the shrinking lake and building up a shell bank as its current was checked on entering the still water.

The coming in of wadi wash, and the dying out of the shells towards the north-east bears out this theory, but further work requires to be done before it can be definitely established.

Finally the marly sand (Bed 3) requires special mention, for it is in this that the abundance and variety of *Lymnæa lagotis* is so astonishing.

Here for the first time the fauna occurs in such a way as to suggest that the shells lived where they are now found, and were not washed down, as is certainly the case in the underlying beds. Further, compared with the latter there is a marked increase in variety, though the actual numbers are not so great. For the first and last time in this or the upper series *Hydrobia peraudieri* (pl. III, figs. 123-131) appears. It is in great abundance and much larger than elsewhere — the spire particularly showing very pronounced elongation when compared with forms from either the low lake levels in Mœris Bay, or from the Birket Qarun (pl. III, fig. 132).

The variations in *Lymnæa lagotis* (pl. I, figs. 64-105) have already been dealt with in the systematic section (p. 5), it remains only to note that some of the same variations are repeated to a lesser extent in other types.

For instance pl. I, figs. 16-32 show that *Lymnæa mœris* has the same tendency towards expansion of the outer lip, and to a certain extent to elongation of the spire. The one *Bulinus truncatus* is quite exceptional, so far as the author's experience of the Faiyum lake beds goes, in the great length of the spire (pl. II, fig. 51). The *Pisidia*, too, are abnormal, as the following

quotation from a letter by Dr. Stelfox shows : "The conditions under which they lived seem to have been so unfavourable that hardly a single shell is normal and many are mere freaks".

That abnormalities occur among these different genera, *Lymnæa, Bulinus,* and *Pisidium,* would seem to indicate some external factor influencing conditions unfavourably. The above genera responded to it, while the Bithynia and Planorbids were apparently unaffected.

A characteristic of all the species in this series is, however, the thinness and transparency of the shells. At the same time forms occur which are exceptionally well developed and larger than any others found in the Faiyum. This is the case with some *Lymnæa lagotis* (pl. I, figs. 92, 93), and with *Planorbis mareoticus* (pl. II, fig. 36). It seems, then, that the evidence is contradictory, on the one hand pointing to unfavourable conditions, and on the other to just the opposite.

Taking all the facts into consideration, the most probable explanation, at the present time, would seem to be that the marly sand was laid down at the margin of the lake in a pool which became eventually isolated from the main sheet of water, while retaining perhaps, for a time, its communication to the north-east with the wadi. The intermittent flow of the latter would maintain favourable conditions for growth, and in the warm and shallow water the shells could reach a large size, as in the case of the *Melanoides tuberculata* found near the margin of the present lake (see p. 85).

If, then, fresh water ceased to replenish the pool and it began to dry up, the variations and abnormalities noted might be called forth in response to the unfavourable conditions so produced. On this theory the largest, most perfect shells should have been found at the base of the deposit. There was certainly a tendency for a concentration in this position, but as far as could be made out all kinds occurred together. In a layer but 10-20 cm. thick, however, such stratification would be difficult to make out. Whatever explanation is accepted finally, it must account for the fact that abnormal forms occur in this layer *only,* the Lymnæas in the underlying beds being perfectly normal. It must also explain the increase in variety and the presence of *Hydrobia peraudieri.* A possible clue to this is obtained in a statement in Mrs. McKenny Hughes' paper on the mollusca of the Cambridge gravels (*op. cit.,* p. 199). Here she notes that in the pools along the river side shells are often found which do not occur in the main body of water.

Some such explanation may account for the relative abundance of types in the marly sand; at the same time the poverty in species generally, the abnormalities, and the presence of *Hydrobia peraudieri,* which favours brackish water, all seem to the author to point to a lake drying up as the result of ever increasing dessication.

PHYSICAL CONDITIONS.

(1) Climatic.

(*a*) *Rainfall.* — Considering the faunas of all the lakes as a whole, a most remarkable negative feature is the entire absence of land shells. In the lists of Pleistocene fluviatile and lacustrine deposits of other parts, be they North, West or Central Africa, Palestine, the Geneva Basin or our English river gravels, scarcely one has yet been found that did not contain a record of terrestial mollusca intermixed with the aquatic.

This extraordinary hiatus in the Faiyum assemblages can hardly be due to insufficient collecting, since some hundreds of faunas have been studied in different parts of the area. Neither can it be attributed to the deposits being out of reach of shore influence, since many of them are from beaches and from shallow water.

In seeking for an explanation, it seems impossible to escape the conclusion that if terrestial mollusca were living in the Faiyum in the Pleistocene and Neolithic they were not near enough to the lake to fall into it, and furthermore, that if they lived in the higher parts, as *Helix desertorum* does now, there was not sufficient run off to carry them into the lake.

At the present time no *Helix desertorum* seem to live near the lake at all, and no dead shells were anywhere within 2 kilom. or so of the northern. shore. The living creature occurs in numbers at the foot of the Gebel Qatrani — the highest and last scarp of the northern margin, where condensation is sufficient to allow of the growth of lichen on the basalt screes.

Another small piece of evidence that points to the reality of the general absence of terrestial mollusca is the fact that the Neolithic folk, who were

inveterate shell collectors, seem to have found no land shells but *Helix desertorum*, which they could have got on the high ground where they collected grit for the querns.

It seems, then, that the apparent absence must be considered a real one, and if this is so, it must have a bearing on the wider question as to the physical conditions that prohibited the existence of terrestial mollusca.

This immediately introduces a consideration of the climates which obtained in the Faiyum Basin in the Pleistocene. Here again there are two divergent views.

According to Messrs. Sandford and Arkell there was abundant rainfall in the Pliocene and throughout Pleistocene times till nearly the end of the Palaeolithic. They base this view on the undoubted occurrence of great storm beaches along the eastern margin of the Faiyum, which they attribute to the shifting of the cyclonic track southward in the Glacial Period.

With the idea of great and even torrential rainfall in the Pliocene the writer is in entire agreement, but faunal and stratigraphic evidence appears to preclude abundant rain *throughout* the Pleistocene. Had this been so the ground must surely have been covered with abundant vegetation that would have provided ideal conditions for land mollusca. That there were periods of greater rainfall in both Palaeolithic and Neolithic times there can be no doubt, but in the writer's opinion this was never enough to give rise to any continuous mantle of vegetation, and not sufficiently wide spread to overcome the faunal isolation, as far as the terrestial forms were concerned, which the writer believes was estabilished by desert conditions prior to the formation of the 30 m. Palaeolithic lake.

(*b*) *Temperature.* — Evidence for the temperature of the Faiyum lakes is difficult to obtain and the following remarks must be considered purely tentative.

The general dominance of African species in both lakes precludes the idea of any great changes, and for the Neolithic lake in particular, there is no justification for assuming any marked variation from the present sub-tropical temperatures.

Two more lines of enquiry on this point remain : — one connected with

the introduction of Palæarctic forms in the Palaeolithic; the other with a consideration of the degree of general development of the shells as a whole.

With regard to the meaning of the presence of Palæarctic species, it can only be suggested that the gradual extension of glacial conditions in Europe must lie at the root of the southward migration of the freshwater fauna. This has been established in Algiers by Pallary (*op. cit.*, 1901) and now for the first time the same trend has been shown to occur in the Eastern Mediterranean, but, as would be expected, to a lesser extent.

From general considerations and evidence in other parts, it seems likely that there was a certain amount of lowering of the temperature in the belt south of the ice sheet. Favre (*op. cit.*, p. 387) has shown that in the postglacial deposits of the Geneva Basin the characteristic Alpine terrestial mollusca are found several hundred metres below the level they normally inhabit at the present day. He concludes from this that there were rigorous continental climatic conditions at that time. Again, Pilsbry and Bequært deduce a general lowering of climatic zones in the Pleistocene from the occurrence in East Africa of identical species on mountain tops now separated by some 40 km. of savannah in which they could not establish themselves.

It seems probable, then, that when the Palæarctic mollusca arrived in the Faiyum they found more congenial temperature conditions than either the Neolithic or the present day would afford. It is possible, therefore, that the disappearance of the Palæarctic species may have been caused by rise in temperature as well as dessication, but the wide thermal latitudes which freshwater mollusca in particular can endure preclude any definite pronouncement on this point.

The question of the relation of size to temperature is a still more difficult one. It seems, however, to be a fact that speaking generally the Faiyum Pleistocene shells are not so big as their modern representatives. This is particularly noticeable in the case of *Viviparus*, *Cleopatra bulimoides*, and *Planorbis alexandrinus*, which are not only much larger at the present day, but also apparently by Ptolemaic times had reached their present dimensions. The evidence for this statement was supplied by what must have been a Ptolemaic irrigation bank damming up a small side valley of the Bats Drain south of the Edwa Bank (p. 94).

It is of interest to note the same tendency in the Tanganika fauna — the *Viviparus* and other fossil shells of Lake Nyassa being smaller than their modern representatives. In the Geneva Pleistocene deposits, too, the same holds true for some species, but not for others.

From the little evidence available, then, this stunting of the Faiyum shells seems to be of more than local occurrence, but whether it can be attributed to a lowering of temperature is far from certain, since so many other factors may produce the same result. Moreover, if temperature did produce it and the Palaeolithic lake were somewhat colder than the Neolithic, the African species should have returned to their normal size in the more favourable conditions of later times. So far as is known, however, this is not the case, the Neolithic shells being no larger than the Palaeolithic, except in the case of some Pisidia, which seem definitely larger at the higher levels of the Neolithic lake.

On the whole, then, it seems more likely that in the case of the Faiyum some other factor (or factors), besides temperature, was at work. Some of these may have been periodic variation of water level, scarcity of suitable food, or relatively greater salinity, all of which according to Kobelt (*op. cit.*, 1870) and Geyer (*op. cit.*, 1925) are capable of producing the same result.

Apart from the general considerations discussed above no conclusive evidence for temperature changes can be given.

(2) Lime Content.

The amount of lime in the lake water has its reflection in the type of shell produced. From the great quantity of limestone forming the basin it seems probable that the lime content of the waters of all the Faiyum lakes was higher than the average.

This, together with the peculiar physical conditions, would account for the pseudo-oolitic grains of the Edwa Bank and elsewhere, and the coating of some shells in the same areas with lime. In the enclosed basins on the north plateau it would also account for the calcification of the reed stems. The general thickening of the individuals in the south and west may also be partly due to the higher lime content as well as increased wave action.

(3) Salinity.

The evidence for the freshness, or salinity of the waters has been discussed under the lake assemblages (p. 78). It need only be said here, that the large amount of salts in the Tertiary rocks, if they were present in Pleistocene times, would have tended to make the lake, even at high levels, more saline than the normal Nile water.

The great abundance of *Unionidæ*, together with the size of *Pisidia* may indicate an increased freshening of the Neolithic lake at its maximum.

(4) Plant Life.

Along the margins of both the Palaeolithic — especially its 22 m. stage — and the Neolithic Lake at about 10 m. there occur beds of loam, with carbonised reed stems. They are not, however, of wide extent or of great thickness and therefore it seems probable that plant life was not very abundant in the lakes. Occasional calcified reed stems occur in the enclosed basins of the northern plateau.

One Chara seed was found in deposits of the Neolithic lake.

The above facts help to support the idea that the rainfall was never sufficiently abundant to give rise to a continuous mantle of vegetation.

COMPARISON WITH OTHER REGIONS AND PROBLEMS OF MIGRATION.

MODERN EGYPT.

The Egyptian fauna of the present day is, as might be expected, much richer than that of the Faiyum Pleistocene and Neolithic lakes.

It consists of some 56 genera, 28 being terrestial, and 28 aquatic.

In considerable measure the poverty of the Faiyum fauna consists in the amazing and complete absence of terrestial forms.

The possible significance of this has been dealt with in a previous section (p. 101), and only the aquatic types need be discussed here.

Excluding the estuarine Cardiums and Scrobiculas, which are also omitted from Pallary's list, there are 23 aquatic genera in the Faiyum deposits, all of which are found in the modern Egyptian fauna.

The missing five are as follows :

Physa, Pseudamincola, Eupera, with *Mutelina* and *Leptospatha* not now regarded as valid genera.

The absence of *Physa,* a widespread and common genus in North Africa, is remarkable and interesting.

When the species are considered, the modern Egyptian fauna shows greater richness in every genus, except the *Pisidia;* it is possible, however, that this is due to insufficient collecting of living species. On the other hand, the Faiyum *Pisidia* represent a European element in Egypt, which was certainly more prominent in the Palaeolithic than it is to-day. This element, shown also by the presence of *Lymnæa lagotis* and the abundance of *Planorbis planorbis,* is the most novel and interesting feature in the old fresh water faunas. Hitherto, while the Mediterranean character of the land fauna has long been recognised (Jickeli, *op. cit.,* 1874) the aquatic shells have been regarded as belonging almost entirely to the Ethiopian province, the few strangers found in the extreme north being attributed by Pallary (*op. cit.,* 1909) to importation by currents or commerce.

Now for the first time the fresh water faunas have been shown to contain a considerable, though still subordinate, proportion of European types.

It is significant that this is true only for the Middle Palaeolithic lake, that is at a time when the southward migration of life caused by the advance of the ice may well have reached its maximum.

The numbers of species in some of the principal genera are shown in the following table (see p. 107); *Cleopatra, Unio* and *Corbicula* have not been included, as the value of the species is here particularly doubtful and the number in the Faiyum has been rigorously restricted.

It will be seen that even when the number of species is the same, as in the case of the *Lymnæa,* they are not always identical.

Out of the 55 species and varieties in the Faiyum lake beds, 16, or 29 o/o, are not now found in Egypt.

Of these 16, 5 are extinct, 5 are now living only in Europe and Asia, and the remaining 6 are found no nearer Egypt than Abyssinia and Central and West Africa, though *Planorbis stanleyi* has recently been recorded at Fashoda.

It would appear, therefore, that the second most striking difference between

GENUS.	NUMBER OF SPECIES IN :		NUMBER THE SAME.
	FAIYUM LAKE BEDS.	MODERN EGYPT.	
Bithynia	5	7	2
Bulinus	1	3	1
Hydrobia	1	4	1
Lymnæa	5	5	3
Pila (Ampullaria)	2	6	2
Planorbis	6	8	5
Pisidium	6	2	1
Aspatharia	2	4	2

the modern and ancient fresh water faunas is the greater number of southern types.

This fact, taken in conjunction with the increase in the northern species at the same time, would seem to point to a greater freedom of movement in both these directions in the Pleistocene. If this is so, it bears out the hypothesis of the coincidence of pluvial and glacial epochs, since the greater tropical rainfall of the glacial periods would necessarily facilitate the observed migrations.

So far the fauna of the two lakes have been considered together, it remains to compare each with the modern types.

As would be expected, the Palaeolithic lake shows the greater divergence, 4 out of the 5 extinct species belonging to that date only.

The closer resemblance of the Neolithic lake faunas to the modern is due, partly to the absence of distinctive types, and partly to the subordination of the European element. On the other hand, the 6 southern species found in the Neolithic (an increase of one, *C. bulimoides* var. *richardi,* on the Palaeolithic) constitutes the main difference between the past and present assemblages.

The above facts are summarised in the following table :

SPECIES NOT NOW FOUND IN THE EGYPTIAN FAUNA.

1. — EXTINCT.

(1) *Bithynia connollyi*	Palaeolithic only.
(2) *Lymnæa mœris*	
(3) *Corbicula vara*	
(4) *Unio fayumensis*	
(5) *Chambardia locardi*	Neolithic only.

II. — NORTHERN ORIGIN.

(6) *Lymnæa lagotis*.....	Palaeolithic only.
(7) *Pisidium henslowanum*.....	
(8) *Pisidium nitidum*.....	Both lakes.
(9) *Pisidium obtusale*.....	Palaeolithic only.
(10) *Pisidium subtruncatum*.....	

III. — SOUTHERN ORIGIN.

(11) *Bithynia neumanni*.....	Both lakes.
(12) *Bithynia tilhoi*.....	
(13) *Cleopatra bulimoides* var. *richardi*.	Neolithic only.
(14) *Cleopatra pirothi*.....	Both lakes.
(15) *Planorbis stanleyi*.....	
(16) *Mutela dubia*.....	

With regard to the species still living in Egypt or the Anglo-Egyptian Sudan, judging from the localities given by Pallary and other collectors there seems to have been a greater extension in the range of some species, both northwards and southwards. These conclusions, must, however, be held liable to modification by subsequent discoveries in the modern types, but for what they are worth they are noted in the following tables :

I. — SHELLS NOW APPARENTLY CONFINED TO THE COASTAL REGIONS.

A. *To Alexandrian Coast.*

(1) *Ferrissia isseli.*
(2) *Hydrobia peraudieri.*
(3) *Planorbis planorbis.*
(4) *Cardium edule* var. (probably also E.).
(5) *Pisidium casertanum.*
(6) *Scrobicularia cottardi* (probably also E.).
(7) *Sphærium pharaonum.*

B. *To Suez Coast.*

(8) *Planorbis laurenti.*

II. — SHELLS NOW APPARENTLY CONFINED TO MORE SOUTHERN REGIONS.

(1) *Pila wernei.*
(2) *Aspatharia hartmanni.*

NORTH WEST AFRICA, ALGERIA AND TRIPOLI.

Five species only are common to north-west Africa and the Faiyum lake deposits. This is all the more remarkable since it is possible to compare faunas in both cases of Pleistocene date, thanks to M. Pallary's book on Algerian fossil forms (*op. cit.*, 1901).

The types in common are as follows :

Bulinus truncatus.
Hydrobia peraudieri.
Melanoides tuberculata.
Planorbis planorbis.
Pisidium casertanum.

The above list refers to Algeria, Tunisia, and Morocco; for Tripoli only three out of the ten known aquatic species are found in the Faiyum; these are :

Bulinus truncatus.
Hydrobia peraudieri.
Melanoides tuberculata.

Every one of the 5 species is living at the present day in Egypt, and, what is more significant, in Syria also. They are, in fact, common circum-Mediterranean types, with the exception of *M. tuberculata* which has an enormously wide range both in Africa and Asia, but not in Europe, and all could have entered Egypt as easily from the north-east as from the west.

There is, therefore, absolutely no definite evidence at all for an east to west, or west to east migration of fresh water types in North Africa in the Pleistocene up to date.

This conclusion is strengthened by the striking dissimilarity of the terrestial fauna of north-east and north-west Africa, which according to Connolly hardly contain a species in common (*Journ. Conch.*, p. 100, 1931).

It seems, therefore, necessary to seek for some sort of barrier to migration in this direction.

Temperature, physiographic features, desert, are all possible preventives to free movement among molluscs.

There seems no ground for postulating any greater hinderance to migration in the Pleistocene temperature of North Africa than exists at the present day. No mountain barrier occours between east and west, and though it is possible that the deep Qattara Depression acted as a trap, yet a more northerly route remains available.

This leaves the rainfall factor as the most probable explanation, and suggests the long-standing isolation of the two areas as the result of desert conditions. This postulated desert zone need not have been broad, but its existence, if accepted, means that the supposed southward shift of climatic zones in the glacial age did *not comprehensively* result in the savannah and Mediterranean conditions that are sometimes rather taken for granted by archæologists and others.

The extraordinary absence of land shells from the Faiyum helps to support the above argument, which is further borne out by Gautier's observation (*Le Sahara,* 1923, p. 52) that the Libyan Desert between the Nile and the sand-hill region is destitute of all traces of old wadis in its central part. Antevs (*The Last Glaciation,* 1928, p. 37) believes that "immense areas were desert during the pluvial epoch as well as to-day".

This aspect has been rather emphasised here as a corrective to the too ready acceptance of a northern Sahara very extensively habitable for man and other animals in the Glacial Ages, but it must not be taken as a denial of the evidences of greater rainfall in some areas now desert, which are incontestable.

A hint of perhaps pre-Pleistocene migration between north-west and north-east Africa is given in the fact that the nearest relatives of three Faiyum Palaeolithic lake shells seem to be found in Algeria and Morocco.

These are :

Lymnæa mæris
Planorbis laurenti.
Unio fayumensis

Lymnæa mæris, as has been pointed out, bears a close resemblance to *Lymnæa cirtana* Paltry, which is found in the Pliocene deposits of Algeria (Pallary, *op. cit.*, 1901, p. 37, 38) together with 8 terrestial and 12 aquatic species.

Planorbis laurenti, according to Pallary, belongs to the group *P. maresi* Bgt., of the Algerian Pleistocene, while *Unio fayumensis* appears to be nearly related to *Unio marteli* Pallary, which is a recent and Pleistocene shell of Morocco.

WEST AFRICA AND ETHIOPIAN REGION.

The resemblances between the Faiyum lake shells and those of West Africa are as numerous as those of north-west Africa are few. This striking contrast strengthens still further the idea of a desert barrier to migration in the north of the Sahara. On the south side there is abundant rain, many river — and lake — systems to provide free communication, and though no one would postulate such conditions for the north, yet even the savannahs have their molluscan life, which might well have found its counterpart across the north of the Sahara in Pleistocene times.

Further, the isolation of north-west Africa from the rest of the continent, as far as Mollusca are concerned, is shown by the absence from its fauna, from Pliocene onwards, of typical Ethiopian genera such as *Cleopatra, Ampullaria, Lanistes, Etheria, Mutela, Aspatharia,* and *Eupera.* Desert must, then, have prevented migration not only from the east, but from the south.

Similarly the typical European elements in the Pleistocene faunas of Algeria and the Faiyum seem to have been prevented from migrating southwards; probably by desert in the case of north-west Africa, for reasons already given, and by temperature and other physical differences in Egypt, for though the Nile always provided an open highway to the south, yet, so far as is known, no European shell ever succeeded in taking advantage of it.

The increase in the number of Ethiopian types in the Faiyum compared with Egypt at the present day has already been noted (p. 108). For the sake of clearness the following table is given, showing *all* the Faiyum shells common to both localities.

Those with an asterisk have a wide range throughout Africa, extending in some cases to the extreme south.

SPECIES COMMON TO WEST AFRICA AND THE FAIYUM.

Bithynia neumanni.
Bithynia tilhoi.
**Cleopatra bulimoides.*
Cleopatra bulimoides var. *richardi.*
**Lymnæa cailliaudi.*
**Lymnæa natalensis.*
**Melanoides tuberculata.*
Pila ovata.
Pila wernei.
Planorbis stanleyi.
Segmentina angusta.
**Viviparus unicolor.*
**Corbicula africana.*
**Etheria elliptica.*
Mutela dubia.
Aspatharia rubens var. *cailliaudi.*
Unio egyptiacus.
Unio teretiusculus.

PALESTINE AND SYRIA.

This region is of special interest in relation to the Faiyum, since an appreciable increase in rainfall in the country between the two areas would provide means of inter-communication for the molluscan faunas.

That this interchange *did* take place in the Pleistocene is indicated fairly conclusively by the presence of abundant *Lymnæa lagotis* in the Faiyum, since this shell is not known elsewhere in Africa, but is common in Palestine and Syria at the present day. This conclusion is much strengthened by the occurrence in the modern Syrian fauna of *Cleopatra bulimoides,* a typical African shell. Further, according to Germain certain Syrian species of *Theodoxus* and *Corbicula* are African forms.

There is, then good evidence that the way was open for free migration between the two regions at some period or periods, though until more is known of the Pliocene and Pleistocene fresh water faunas of both countries it is impossible to date these periods exactly.

By the Middle Palaeolithic, a Syrian shell had spread and multiplied in the Faiyum — some 400 kilom. away. When did *Lymnæa lagotis first* arrive in Egypt? We do not know. Nor can we answer the puzzling question as to why the genus *Melanopsis,* so common in Syria and North-West Africa at the present day, disappeared from Egypt after the Pliocene and never returned.

One most interesting record from Palestine may throw some light on the length of time African species survived in an alien land. Thanks to the generosity and kindness of Professor Sir Flinders Petrie the following discoveries in Wadi Ghuzzeh, South Palestine, are allowed to appear for the first time.

In digging a Bronze Age mound, quantities of large fresh water bivalves were found, some nicked along the edges in the manner so beloved of prehistoric peoples (pl. VI, fig. 4). These caught the author's eye at the recent exhibition (July 1930), and on examination they proved to be specimens of *Mutela cf. dubia, Aspatharia cf. rubens,* and *Aspatharia cf. hartmanni* (pl. VI, figs. 4,1 and 3,2).

Now both these genera are *typical* African forms, and have so far not been recorded outside of Africa. They are certainly not constituents of the modern molluscan fauna of either Palestine or Syria.

There is a possibility that the shells were traded with Egyptian folk, but if on investigation this proves not to be the case, the occurrence of these three shells establishes beyond doubt the north eastward migration of Nilotic forms. Moreover, it would point to a Palaeolithic (or Neolithic) date for such migration, since the *Mutela* is *not* the common *M. nilotica* or *ægyptiaca,* but practically identical with the West African *Mutela dubia* of the Faiyum lake beds.

The author hopes to be able to visit the site shortly, to establish the mode of occurrence of these interesting finds [1].

The other forms common to the Faiyum and Syria are those of circum-Mediterranean range, and not of such interest, though it is probable that the shells reached Egypt by the much used Palestinian highway.

The full list of similar species is given below :

SHELLS COMMON TO THE FAIYUM AND SYRIA AND PALESTINE.

Bulinus truncatus.
Cleopatra bulimoides.
Hydrobia peraudieri.

[1] With the invaluable help of Mr. J. L. Starkey, the author spent six days up the wadi, but did not find any of the shells *in situ.* There did not, however seem to be any deposits suitable for their preservation, and further search in other parts is required.

Lymnæa lagotis.
Melanoides tuberculata.
Planorbis planorbis.
Pisidium casertanum.
? Mutela dubia.
? Spatha rubens var.
? Spatha hartmanni.

The conclusions to be drawn from the facts discussed in the above section may be summarised as follows :

(1) That in the Pleistocene there was a northward "rush" of southern shells, which did not spend itself till Palestine was reached.

(2) That this 'rush' was followed in late Neolithic times by the dying out or southerly retreat of the majority of these Ethiopian forms both from the Faiyum and Palestine.

(3) That though there may have been pre-Pleistocene communication between North-West and North-East Africa, in later periods there is no evidence for any molluscan migration in either direction, so far as the known data are concerned.

(4) That in the Pleistocene, a southerly migration from Palestine and Syria led to the establishment in the Faiyum of the European element characteristic of the Palaeolithic lake, but absent from the Neolithic.

DISTRIBUTION LIST OF FAIYUM LAKE SHELLS.

SPECIES.	AFRICA. FAIYUM. PLEISTOCENE LAKE. Gravels 35 m. NORTH.	Gravels 35 m. EAST-SOUTH.	Gravels 35 m. WEST.	WHITE CLAYS.	22 to 5 m. NORTH.	22 to 5 m. EAST-SOUTH.	22 to 5 m. WEST.	1 to -2 m. QASR GEBALI.	1 to -2 m. TAMIYA BANK.	1 to -2 m. EDWA BANK.	NEOL. LAKE. 18 to 0 m.	NEOL. LAKE. Below 0 m.	BIRKET-el-QARUN.	EGYPT. LOWER.	EGYPT. UPPER.	EGYPT. FOSSIL.	WHITE NILE.	ABYSSINIA.	CENTRAL and EAST.	LAKE CHAD & WEST.	NORTH-WEST.	SOUTH.	TERTIARY.	PLEISTOCENE.	POST-PLEISTOCENE.	EUROPE.	ASIA.
BITHYNIA connollyi.	+			+	+	+	+	+	+	+																	
– goryi.					+	+			+	+	+	+		+	+		+									Mediterranean Region.	
– neumanni.							+		+	+		+						+	+	+							
– senaariensis.				+	+	+	+	+	+		+	+		+	+		+	+									
– tilhoi.					+	+	+		+			+							+	+							
BULINUS truncatus.				+				+	+	+	+	+	+	+	+	+	+	+			+			N.W. +	N.W. +	Mediterranean Region.	Near East.
FERRISSIA isseli.												+		+													
CLEOPATRA bulimoides.	+			+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+		var. +	Cent. +				Near East.
– – var. richardi.												+								+		S.W. +					
– pirothi.				+						+	+	+				+		+	+								
HYDROBIA peraudieri.									+	+			+	+	+		+				+		N.W. +	N.W. +			Near East.
LANISTES carinatus.					+		+	+				+		+	+	+	+	+	+				Cent. +				
– – var. perfecta.												+		+	+												
LYMNAEA caillaudi.				+	+	+				+		+		+	+		+	+	+	+		+					
– lagotis.	+			?+		+	+	+	+	+																S.E., N.Central & Mediterran.	Near, Middle East.
– moeris.								+	+	+																	
– natalensis.	+			+	+					+		+		+	+		+	+	+	+		+					
– ? truncatula.	+													+	+		+	+	+		+	+		N.W. +	N.W. +	S.E., N.Central & Mediterran.	Near East.
MELANOIDES tuberculata.	+		+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Cent. +	N.W. +			Near Middle & Far East
PILA (AMPULLARIA) ovata.				+	+						+			+	+	+	+	+	+	+							
– wernei.					+										+		+	+		+							
PLANORBIS alexandrinus.				+	+		+				+			+	+	+	+	+	+								
– ehrenbergi.					+			+	+		+	+	+	+	+	+											
– laurenti.				+	+			+			?+			+													
– mareoticus.	+			+	+			+	+	+		+	+	+	+												
– planorbis.	+		+	?+	+	+	+	+	+	+			+	+							+		N.W. +			N.Central & Mediterranean.	Near East.
– stanleyi.				+	+		+	+		+		+					+	+	+								
SEGMENTINA angusta.					+							+		+	+		+	+	+	+							
SUCCINEA cleopatrae.											?+			+	+												
THEODOXUS niloticus.				+	+		+	+		+	+	+	+	+	+	+											
VALVATA nilotica.	+			+	+	+	+	+	+	+		+	+	+	+	+											
VIVIPARUS unicolor.				+	+		+	+	+	+	+	+		+	+		+	+	+	+		+	Cent. +		+		
ASPATHARIA rubens, var. caillaudi.	+				+							+			+	+	+	+	+		+						
– wahlbergi hartmanni.											+				+		+		+								
CARDIUM edule, var.													+	+												Mediterranean, etc.	
CHAMBARDIA locardi.												+					+										
CORBICULA africana.	+	+		+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+		+	Cent. +				
– artini.	+	+	+		+			+	+	+	+			+	+	+	+	+		+				N.W. +	S.E. (LP = fluminalis).	Near East.
– consobrina.	+	+			+			+	+	+	+	+	+	+	+	+	+	+	+						Fossil in N.W.	
– vara.		+	+							+																	
ETHERIA elliptica.		+										+		+	+	+	+	+	+	+			Cent. +				
MUTELA dubia.					+							+					+		+	+							
PISIDIUM ?casertanum.									+					+							+		N.W. +		N.Central. Fossil (Pleist.).	Near East.
– sp. ?clarckeanum.												+		+													Middle East (India)
– ?henslowanum.									+																	N.Central.	
– ?nitidum.									+			+									+					N.Central. Fossil (Pleist.)	
– ?obtusale.									+																	N.Central.	
– ?subtruncatum.									+																	N.Central.	
SCROBICULARIA cottardi.													+	+												Mediterranean.	
SPHAERIUM pharaonum.												+		+				+									
UNIO (CAELATURA) egyptiacus.				+						+		+		+	+		+		+	?+							
– fayumensis (= schweinfurthi).										+																	
– (CAELATURA) niloticus.					+						+			+	+		+		?+	?+							
– – parreyssi, var. petrettinii.												+		+													
– teretiusculus.					+			+				+		+	+		+			?+							

NOTE. — A query in the species column means the identification is uncertain, in other columns the locality or age is questioned.

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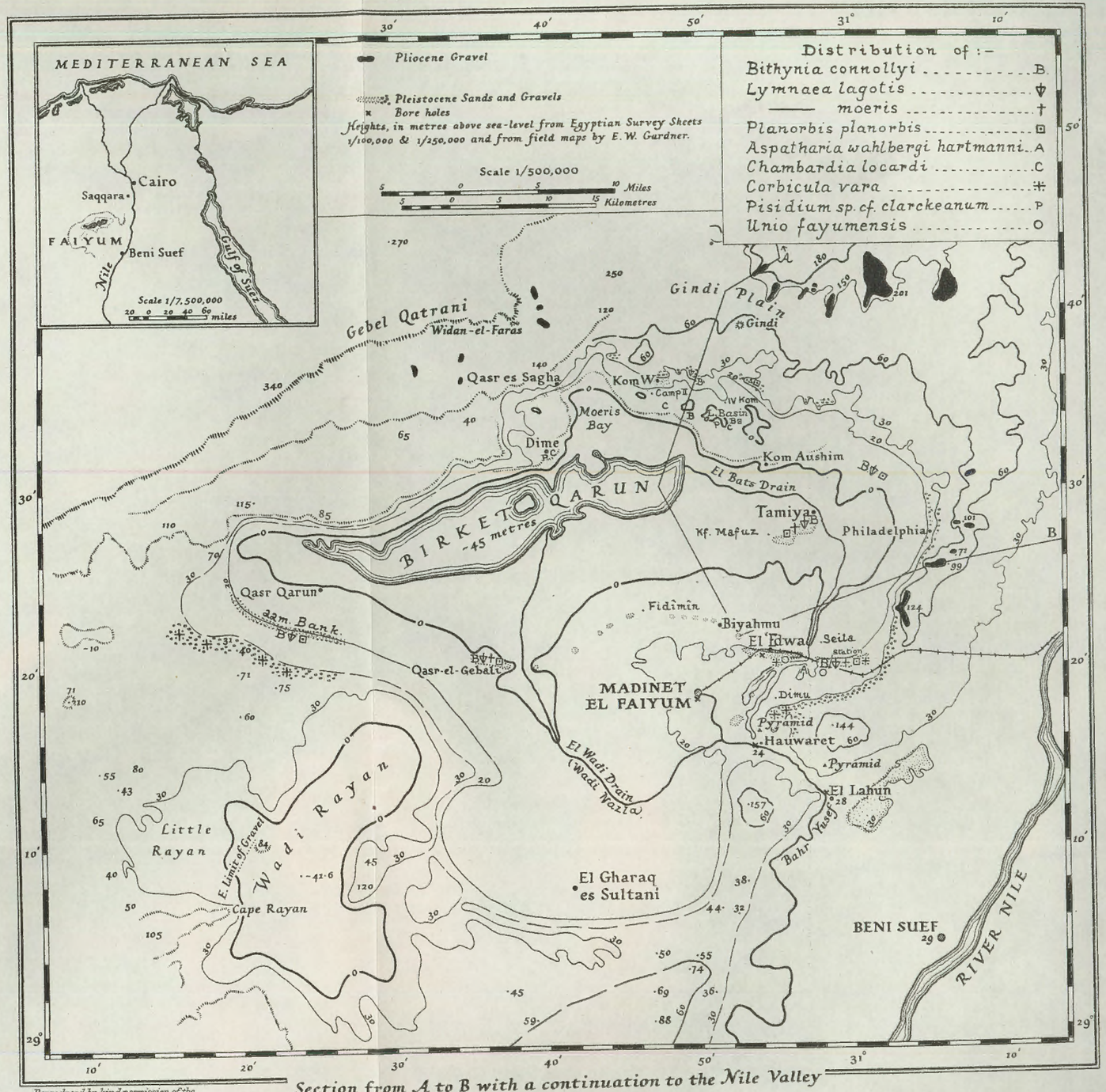
INDEX TO SPECIES.

Species are arranged under their respective genera, and both are placed in alphabetical order.
Description in the systematic section is indicated by figures in heavy type.
Synonyms are given in italics.

THE FAIYUM DEPRESSION.



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Section from A to B with a continuation to the Nile Valley

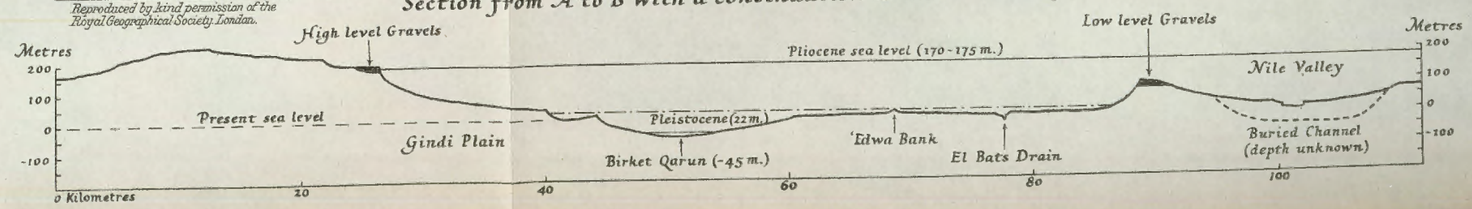

PLATE I.

(All $\frac{4}{5}$ natural size).

Figs. 1-2. — *Succinea cleopatræ* Pallary. West Edwa Bank . . . . . p. 1
3. — *Lymnæa palustris* (Müller). Quaternary, Weimar . . . . . p. 13
4-32. — *Lymnæa mœris* Martens. Pleistocene . . . . . p. 12
4. — from Schweinfurth's collection. Berlin.
5-15. — from the Edwa Bank.
16-32. — from the Tamiya Bank.
33-37. — *Lymnæa natalensis* Krauss . . . . . p. 8
33-36. — from the Pleistocene lake near Qasr-es-Sagha.
37. — from the Neolithic lake near Dimê.
38-44. — *Lymnæa cailliaudi* Bourguignat . . . . . p. 11
38-42. — Low level Pleistocene forms. N. Faiyum.
43-44. — Higher level Pleistocene forms. N. Faiyum.
45-105. — *Lymnæa lagotis* Schrank. Pleistocene . . . . . p. 2
45-52. — from the 22 m. bank. W. Faiyum.
53-63. — from the Edwa Bank.
64-105. — from the Tamiya Bank.

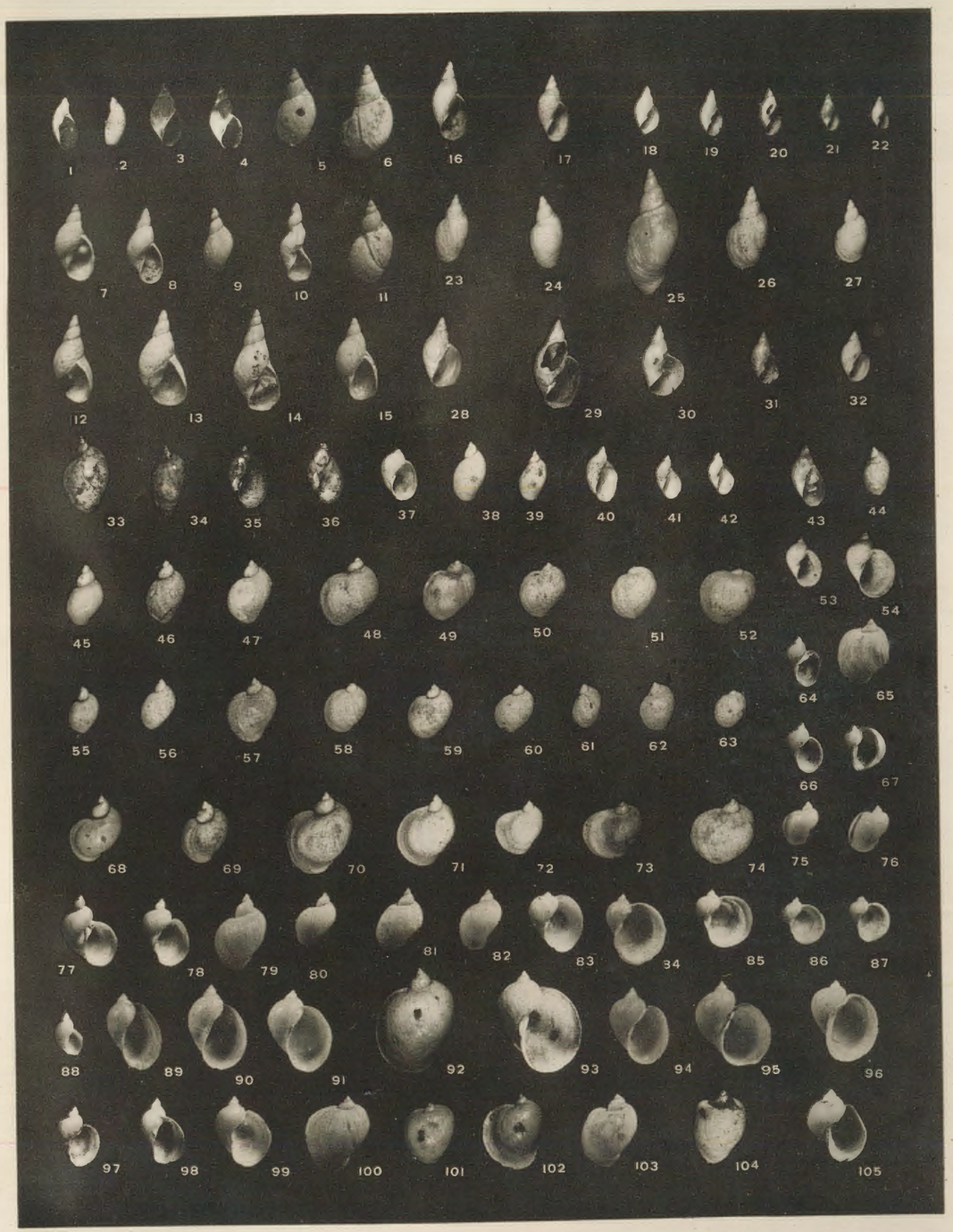

PLATE II.

($\frac{4}{5}$ natural size, unless the contrary is stated).

Figs. 1-11. — *Planorbis alexandrinus* Ehrenberg . . . . . p. 14
1. — Pleistocene white clays near Dimê.
2. — Pleistocene sands near Qasr-es-Sagha.
3. — Neolithic sands near Dimê.
4-7. — Sand near Fîdîmîn. Fig. 7 × $1\frac{3}{5}$.
8-10. — Neolithic sand. N. Faiyum.
11. — Ptolémaic embankment. S. of Edwa Bank.

12-18. — *Planorbis stanleyi* Smith . . . . . p. 16
12-13. — Neolithic sand. N. Faiyum.
14. — Pleistocene sand. N. Faiyum.
15-18. — Pleistocene white clays near Dimê.

19-21. — *Planorbis ehrenbergi* Beck. Pleistocene clays near Dimê, × $1\frac{3}{5}$ . . . . p. 21

22-24. — *Planorbis laurenti* (Bourguignat) Innes. Pleistocene sands near Qasr-es-Sagha, × $1\frac{3}{5}$ . . . . . p. 20

25-34. — *Planorbis planorbis* (Linneaus). Pleistocene . . . . . p. 17
25, 27-34. — from 22 m. bank West Faiyum.
26. — from Tamiya Bank.

35-40. — *Planorbis mareoticus* (Let.) Innes. Pleistocene Tamiya Bank . . . . . p. 20

41-45. — *Segmentina augusta* Jickeli. Neolithic sands near Camp II, × $1\frac{3}{5}$ . . . p. 22

46. — *Ferrissia isseli* (Bourguignat). Neolithic 'L' Basin × $7\frac{1}{5}$ . . . . . p. 24

47-51. — *Bulinus truncatus* (Audouin) . . . . . p. 23
47-49. — Pleistocene clays near Dimê.
50. — Neolithic clays. N. Faiyum.
51. — Pleistocene clays. Tamiya Bank.

52-54. — *Lanistes carinatus* (Olivier) . . . . . p. 26
52-53. — Pleistocene clays and loams. Dimê.
54. — Young shell from Neolithic sands.

55-56. — *Lanistes carinatus* var. *perfecta* Pallary. Pleistocene clays and loams near Dimê . . . . . p. 26

57-58. — *Pila wernei* (Philippi). Pleistocene. N. Faiyum . . . . . p. 25

59-60. — *Pila ovata* (Olivier). Pleistocene white clays. Dimê . . . . . p. 24

61-63. — *Viviparus unicolor* Olivier . . . . . p. 27
61-62. — Neolithic sands. N. Faiyum.
63. — Ptolemaic embankment. S. of Edwa Bank.

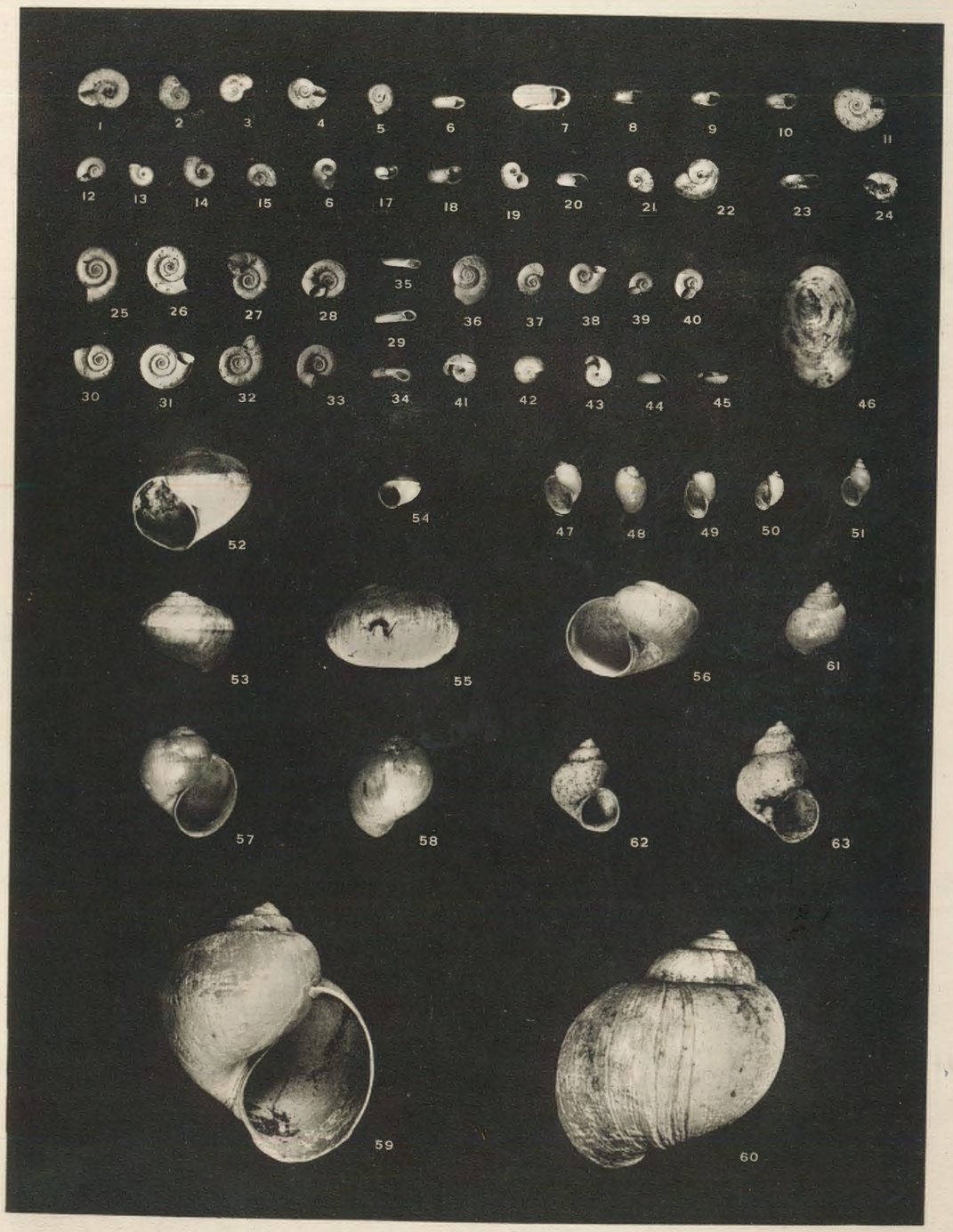

PLATE III.

($\frac{4}{5}$ natural size, unless the contrary is stated).

Figs. 1-16. — *Melanoides tuberculata* (Müller) ..... p. 31
1-11. — from recently dried pool near N. shore Birket Qarun.
12-16. — Slender 'race'. Pleistocene sands. N. Faiyum.
17-22. — *Cleopatra pirothi* Jickeli. Neolithic sands. Dimê ..... p. 30
23-27. — *Cleopatra bulimoides* (Olivier) ..... p. 28
23-24. — Pleistocene clays. Dimê.
25-26. — Pointed 'race' from Pleistocene clays E. of Camp. II.
27. — Faintly carinated forms. Low level Neolithic.
Figs. 28-32. — *Cleopatra bulimoides* var. *richardi* Germain. Neolithic sands 'L' Basin. N. Faiyum ..... p. 29
33 63. — *Bithynia connollyi* Gardner. Pleistocene ..... p. 33
33-39. — Edwa Bank.
40-48. — S. Tamiya Bank. (Type f-40).
49-58. — 22 m. Bank. N. Faiyum.
59-60. — Type from the S. Tamiya Bank, $\times 1\frac{3}{5}$.
61-63. — 22 m. Bank, $\times 1\frac{3}{5}$.
64-67. — *Bithynia* sp. nov. from Schweinfurth's collection. Berlin ..... p. 34
68-71. — *Bithynia* labelled 'Boissieri' from Schweinfurth's collection Berlin ..... p. 92
72-73. — *Bithynia connollyi* Gardner. Immature forms from Edwa Bank, $\times 1\frac{3}{5}$ ..... p. 33
74-77. — *Bithynia goryi* Bourguignat. Neolithic. N. Faiyum, $\times 1\frac{3}{5}$ ..... p. 35
78-80. — *Bithynia senaariensis* Parreyss. Neolithic. N. Faiyum, $\times 1\frac{3}{5}$ ..... p. 35
81-83. — *Bithynia tilhoi* Germain. Pleistocene, 22 m. Bank. W. Faiyum, $\times 1\frac{3}{5}$ ..... p. 37
84-86. — *Bithynia neumanni* Martens. Pleistocene. 22 m.Bank. W. Faiyum, $\times 1\frac{3}{5}$ ..... p. 36
87-122. — *Theodoxus niloticus* (Reeve) ..... p. 40
87-106. — Sand. N. Faiyum
107-114. — Rocky habitat. N. Faiyum.
115-122. — Low level. Mœris Bay.
123-134. — *Hydrobia peraudieri* Bourguignat ..... p. 38
123-131. — from Tamiya Bank. (123-124, $\times 1\frac{3}{5}$).
132. — N. shore Birket Qarun, $\times 1\frac{3}{5}$.
133-134. — Low level Neolithic lake, $\times 1\frac{3}{5}$.
135-136. — *Valvata nilotica* Jickeli. Pleistocene clays. N. Faiyum, f. 135, $\times 1\frac{4}{5}$ ..... p. 40

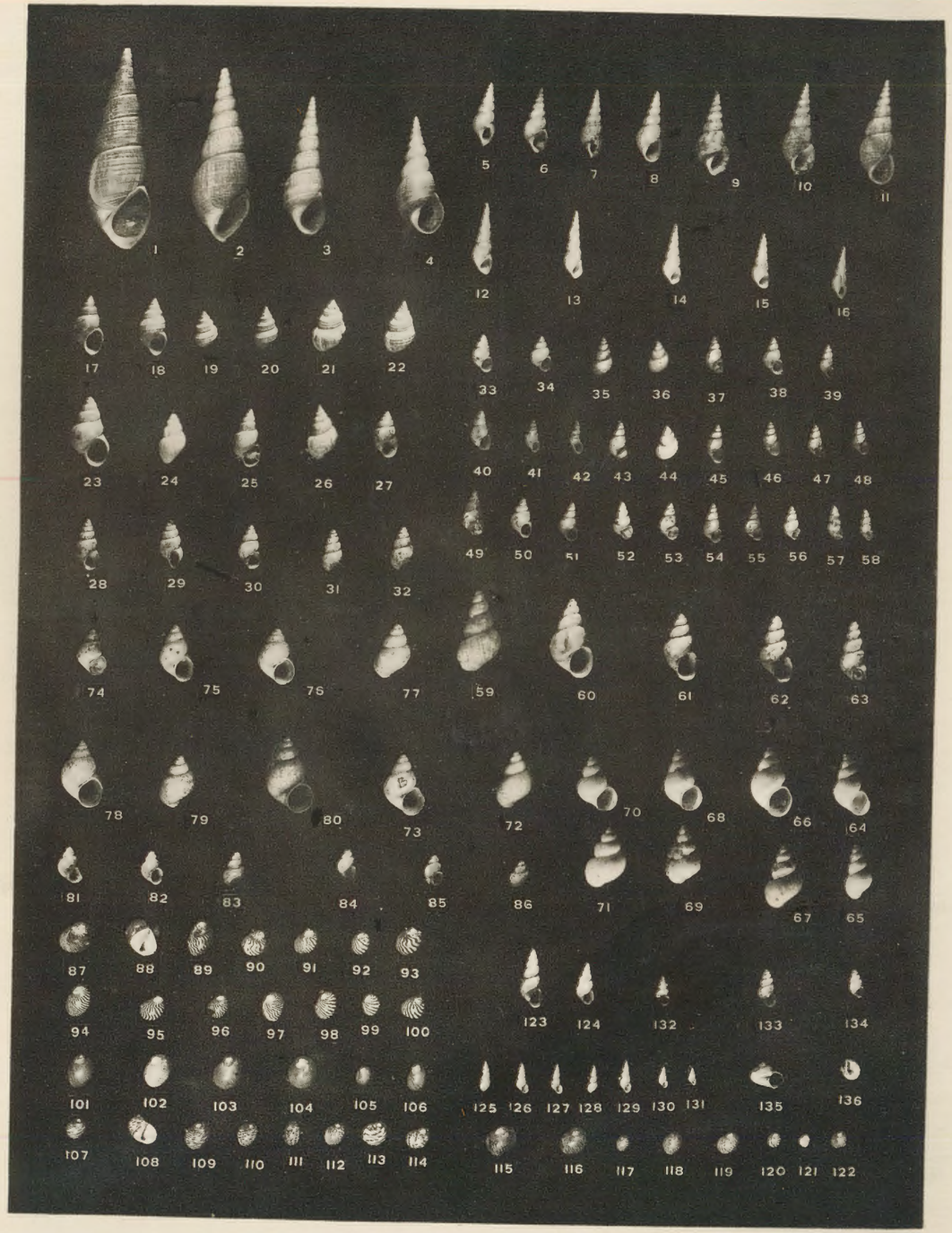

PLATE IV.

(All $\frac{4}{5}$ natural size).

Figs. 1-9. — *Cælatura egyptiaca* (Cailliaud) . . . . . p. 46

1. — Cailliaud's type.

2-3. — from clays. S. Seila Station.

4-9. — among rocks. Neolithic near Dimê. S. of Camp II.

10-13. — *Cælatura parreyssi* var. *petrettinii* (Bourguignat). Neolithic sands. Dimê . . . . . p. 49

14-22. — *Cælatura nilotica* (Cailliaud) . . . . . p. 48

14. — Cailliaud's type.

15-17, 19. — from clays. S. Seila Station.

18, 22. — from clays. Nazla Road. Wadi Nazla.

20. — from clays. N. end Wadi Nazla.

21. — from coarse gravel. S. of Edwa Bank.

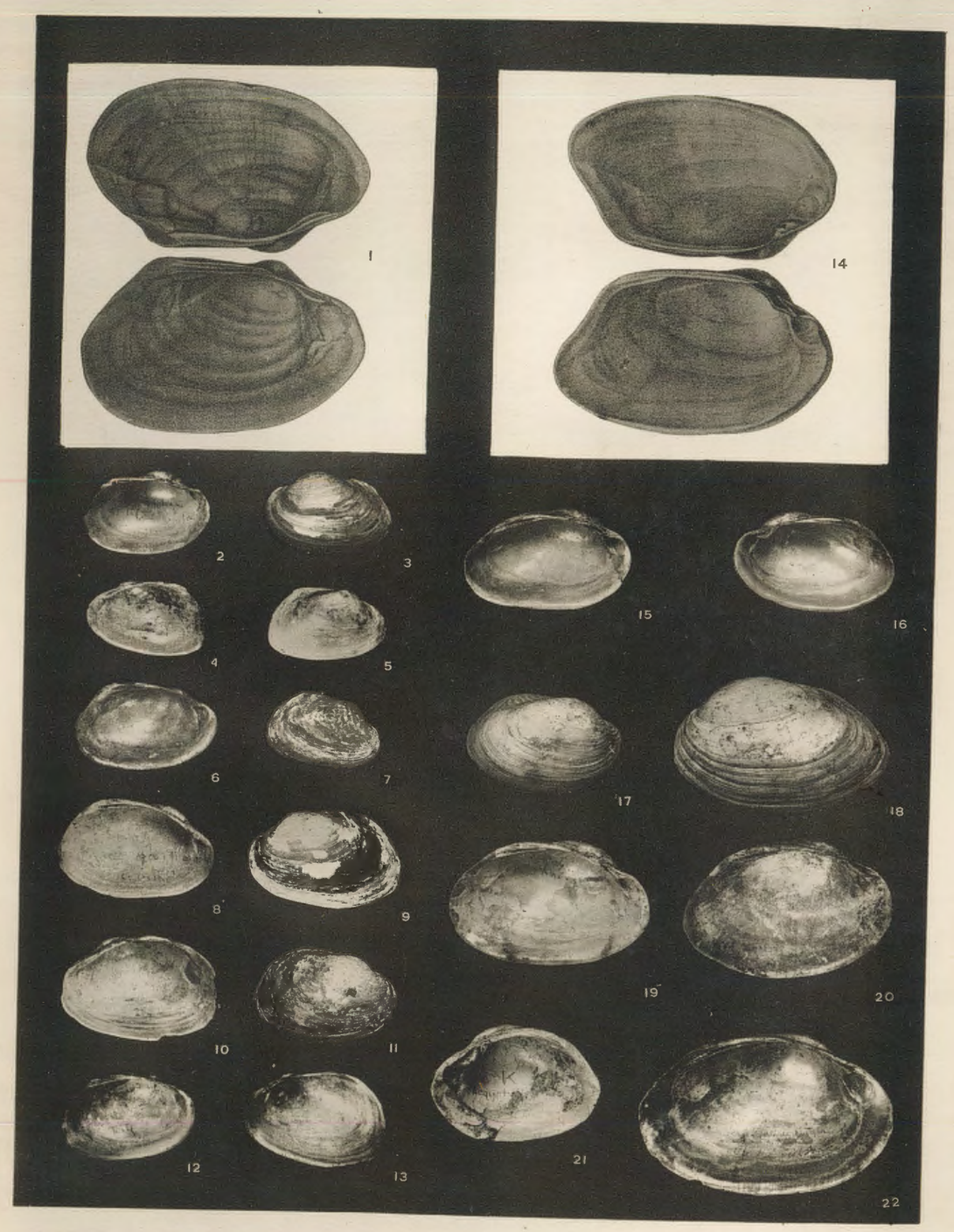

PLATE V.

(All $\frac{4}{5}$ natural size).

Figs. 1-5. — *Unio teretiusculus*. Philippi . . . . . p. 50
1-2. — Wadi near IVth Dynasty Kom. N. Faiyum.
3-5. — Neolithic sand. 'L' Basin. N. Faiyum.
6-9. — *Cælatura egyptiaca* (Cailliaud) . . . . . p. 47
6-7. — Wadi near IVth Dynasty Kom. N. Faiyum.
8-9. — Rocky habitat. Neolithic lake. N. Faiyum.
10-16. — *Unio fayumensis* Pilsbry and Bequaert. Pleistocene . . . . . p. 51
10-11. — Type locality Edwa Bank.
12-13. — Coarse gravel. S. of Edwa Bank.
14-16. — Schweinfurth's collection. Berlin.
17-18. — *Unio willcocksi* Newton. Labelled «Unio Schweinfurthi from near Luxor». Berlin collection . . . . . p. 51
19-20. — *Aspatharia rubens* var. *cailliaudi* Martens. Neolithic lake. N. Faiyum. p. 53

PLATE VI.

(All $\frac{4}{5}$ natural size).

Figs. 1, 3. — *Aspatharia cf. rubens?* (Cailliaud). Bronze Age Site. Wadi Ghuzzeh. S. Palestine..... p. 113

2. — *Aspatharia cf. wahlbergi hartmanni?* (Martens). Wadi Ghuzzeh. S. Palestine..... p. 113

4. — *Mutela dubia?* (Gmelin). Wadi Ghuzzeh. S. Palestine..... p. 113

5. — *Mutela dubia* (Gmelin). Neolithic. N. Faiyum..... p. 55

6-9. — *Aspatharia wahlbergi hartmanni.* (Martens) Neolithic?. S. of Edwa Bank. E. of Bats..... p. 53

10-13. — *Chambardia locardi* Bourguignat. Rocky habitat. Neolithic. Dimê. p. 54

14. — *Etheria elliptica* Lamarck. Rocky habitat. Neolithic. Dimê..... p. 56

PLATE VII.

(All $\frac{4}{5}$ natural size).

Figs. 1-11. — *Corbicula vara* Gardner. Pleistocene ..... p. 58
1-3, 5, 7-11. — 30 m. gravels. W. Faiyum. Types 1, 8, 9.
4, 6. — Edwa Bank (f. 4 in coarse gravel S. of Bank).
13-14. — *Corbiculæ* intermediate in length-height ratio between *C. vara* and *C. artini*. Edwa Bank and Hawara ..... p. 60
12, 15-22. — *Corbicula artini* Pallary ..... p. 60
12, 15-19. — Qasr Qebali.
20. — 30 m. gravels. W. Faiyum.
21. — Edwa Bank.
22. — coarse gravel. S. of Edwa Bank.
23-24. — *Corbiculæ* intermediate in length-height ratio between *C. artini* and *C. consobrina* ..... p. 61
23. — 30 m. gravels. N. Faiyum.
24. — Qasr Qebali. W. Faiyum.
25-42. — *Corbicula consobrina* (Cailliaud) ..... p. 61
25, 26, 29. — Edwa Bank.
33. — 30 m. gravels. W. Faiyum.
27, 28, 35-42. — 30 m. gravels. N. Faiyum.
43-44. — *Corbicula innesi* Bourguignat. Geneva Museum ..... p. 60
45-47. — *Corbicula consobrina* (Cailliaud). Cambridge river gravels ..... p. 63
48-49. — *Corbicula consobrina* (Cailliaud). Modern forms from canal. W. Faiyum ..... p. 61
50-54. — *Corbicula africana* (Krauss). Neolithic sand. Dimê ..... p. 64
55-59. — *Scrobicularia cottardi* Payraudeau. N. shore Birket Qarun ..... p. 70
60-70. — *Cardium edule*. var. Linnæus ..... p. 71
60-62. — N. shore Birket Qarun. Faiyum.
63. — Lake Mareotis. Bateson Collection.
64. — Ramleh. Bateson Collection.
65. — Abukir. Bateson Collection.
66-68. — S. shore. Birket Qarun.
69-70. — Isolated pools. Sussex. Tomlin Collection.

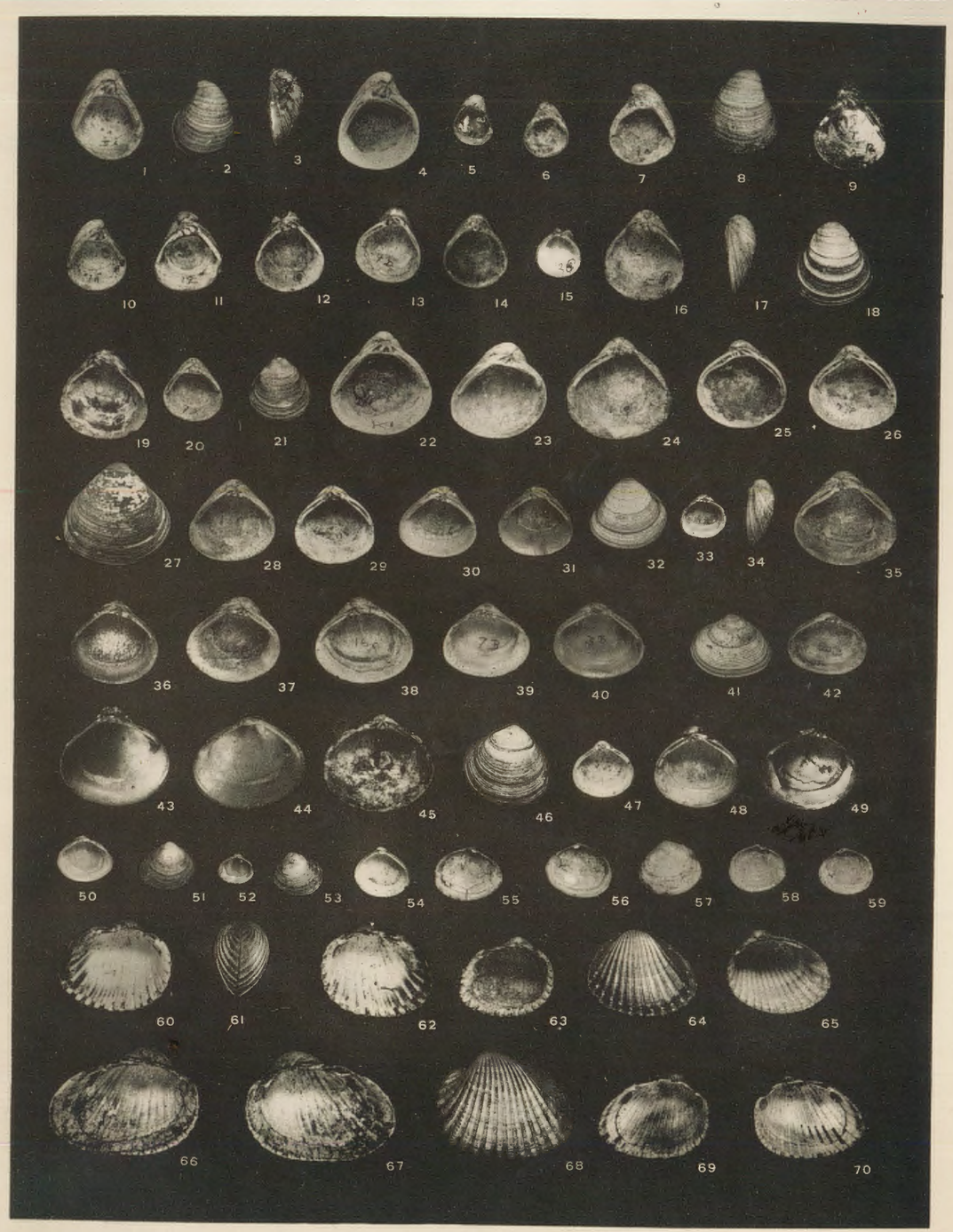

PLATE VIII.

(Fig. 22 $\frac{4}{5}$ natural size, all others $\times 7\frac{1}{5}$).

Figs. 1-4. — *Pisidium henslowanum* (Sheppard)? Pleistocene. Tamiya Bank..... p. 66
5-12. — *Pisidium nitidum* Jenyns?..... p. 66
5-8. — Pleistocene. Tamiya Bank.
9-12. — Neolithic. N. Faiyum.
13-14. — *Pisidium casertanum* (Poli)? Pleistocene. Tamiya Bank..... p. 67
15-20. — *Pisidium sp? cf. clarckeanum* G. and H. Nevill. Neolithic..... p. 68
15-18. — Sand at + 2 m. 'L' Basin.
19-20. — Sand at + 10 m. Dimê.
21. — *Sphærium pharaonum* Bourguignat. Neolithic sands. Dimê..... p. 70
22. — Shell conglomerate from 22 m. bank W. Faiyum. Pleistocene.